Elenia Verkko Oyj's electricity distribution network development plan

2014–2036

Contents

Introduction

Elenia – a trusted builder of sustainable growth

As part of responsible, cost efficient and long term electricity network development, we have updated our electricity distribution network development plan covering the period up to 2036. The development plan is based on updated electrification forecasts and on ensuring compliance with the requirements of the Electricity Market Act.

We secure critical infrastructure and the security of supply for society 24/7

Electricity distribution is an essential part of critical infrastructure and must ensure the uninterrupted functioning of society under all conditions and at all times. Without electricity, a modern society and its services do not function. Disruptions in electricity distribution must be remedied, and the supply of electricity to our customers must continue in any situation. In addition to challenging weather conditions, uninterrupted electricity distribution must also be prepared for a wide range of other threats, such as hybrid interference and cyber disruptions.

We prepare for these various threats and ensure the continuity of our operations in accordance with our up-to-date preparedness and contingency plan and our playbook for major power disruptions, together with our partners. We maintain round-the-clock readiness every day of the year. We cooperate closely with other operators in the sector and with authorities as part of the Finnish security of supply community. We take the tightening security situation in Europe into account, particularly with regard to material availability, hybrid interference and cyber threats.

Long-term work to ensure the security of electricity supply is still ongoing

Under the Electricity Market Act, after 2036 there must be no power outages exceeding 6 hours in zoned areas, and no interruptions exceeding 36 hours outside zoned areas, as a result of storms or snow loads. By far the majority of power outages experienced by customers are caused by trees falling on medium-voltage overhead lines. Rising temperatures and increasing annual precipitation resulting from climate change will reduce soil frost and increase heavy snowfall. As a result, the risks and impacts of storms and snow loads on electricity distribution will increase, even if the weather phenomena themselves do not intensify.

The quality requirements set out in the Electricity Market Act, the increasing dependence of societal functions on electricity, and our customers' growing expectations for uninterrupted electricity distribution guide us to favour underground cabling in the refurbishment of the ageing electricity network. Underground power cables are protected from the effects of extreme weather events, and as underground cabling progresses, storm-related damage to the electricity network and the resulting customer impacts are reduced.

The Jari storm in November 2024 and the Hannes storm in December 2025 demonstrated that Elenia's network and the Finnish electricity system remain significantly vulnerable. The Hannes storm alone felled an estimated more than 20,000 trees onto Elenia's overhead lines, leaving 76,000 of our customers without electricity. Some customers experienced outages lasting more than a week in winter conditions. In total, 2,800 fault repair tasks were carried out in our electricity network.

Since 2012, we have built more than 35,000 kilometres of weatherproof underground cable network—replacing vulnerable overhead lines—and increased the underground cabling rate of our network from 23 per cent to over 66 per cent. Without our substantial network investments exceeding EUR 1.8 billion, the Hannes storm would have been a catastrophe for our customers and for society.

In line with our development plan, our strategic objective is to increase the underground cabling rate of the electricity network to 90 per cent by the end of 2036. This requires the construction of more than 20,000 kilometres of new underground cable network, replacing ageing and weather-exposed overhead lines. This will ensure high-quality electricity distribution for our customers and compliance with the quality requirements of the Electricity Market Act.

As underground cabling progresses, we install automation devices at key nodes of the electricity network, significantly accelerating fault isolation and the restoration of electricity supply to customers in various fault situations. In areas awaiting network renewal, security of supply is further ensured through targeted maintenance, efficient fault repair and major disturbance operations.

The construction of the underground cable network also enables cost-efficient joint construction of fibre-optic networks and other infrastructure networks in connection with the refurbishment of the electricity distribution network. We are one of the industry forerunners in joint construction, and we believe that there will continue to be a need for joint construction as society electrifies further, digitalisation advances and remote work become more widespread.

The energy transition challenges network capacity and requires investments

The energy transition requires the electrification of energy use and increasing electricity generation from renewable energy sources, both of which increase the capacity needs of the electricity network. Ensuring sufficient network capacity requires substantial investments, particularly in the high-voltage network and substations. The available capacity of our electricity network has decreased significantly, and approximately 35 per cent of the network is subject to constrained capacity conditions. Our development plan includes investments and various flexibility solutions to secure sufficient capacity both now and in the future based on assessed needs.

Production of renewable wind and solar power has grown rapidly in recent years. More than 1,600 MW of wind power capacity has already been connected to our network, representing approximately one-sixth of Finland's total wind power capacity. Our network includes nearly 20,000 small-scale generation sites, meaning that about five per cent of our customers have small-scale renewable production.

Over the past two years, various electricity energy storage solutions have also become increasingly common. A total of 88 MW of industrial-scale electricity storage has been connected to our network, with new connections being built at an accelerating pace. In addition to industrial-scale storage, household energy storage solutions, i.e. home batteries, have also become more widespread, with their current number approaching 1,200. In line with the development plan, we estimate that the number of home batteries will follow the growth in small-scale generation sites over the next 15 years.

Electric vehicles are becoming more common, and at the same time charging infrastructure—both home charging and public charging stations—is expanding and requires additional capacity from the electricity network. Replacing fossil-based heating solutions requires electricity, as does the electrification of industrial processes. In particular, the electrification of heat production through power-intensive electric boilers represents a significant change trend compared to the 2024 development plan.

Enabling the energy transition requires Elenia not only to invest in the network but also to develop digital solutions and to facilitate and utilise flexibility. A good example of this is our meter reform. We have replaced our electricity meters with next-generation smart meters that enable Flexibility solutions for our customers and the full utilization of renewable energy.

An uncertain regulatory environment complicates long-term operations

The Energy Authority supervises the operations of Finnish electricity network companies and the reasonableness of their pricing. Regulation is based on four-year regulatory periods. The current sixth regulatory period began on 1 January 2024 and will end at the end of 2027. In accordance with the regulatory principles, the same regulatory methods are also applied during the seventh regulatory period in 2028–2031.

The current regulatory methods and the ongoing uncertainty of the regulatory environment, manifested through unforeseen negative changes, do not enable anticipatory investment decisions. In practice, this means that even investment volumes for the coming years may need to be revised at short notice. Investment decisions must be made for future years with confidence in the stability of the regulatory environment and its incentives for investment, enabling us to respond to the needs of society and our customers in terms of security of supply, reliability of electricity distribution and sufficient network capacity. Regulation should recognise that the investment need presented in the updated development plan is higher than ever before.

Our climate targets are ambitious

We are committed to the science-based climate targets defined in 2021 in accordance with the Science Based Targets initiative. The most significant objective is Net Zero, meaning net zero greenhouse gas emissions, by 2050. In addition, we have set an ambitious target to be carbon-neutral in terms of direct (Scope 1) and indirect (Scope 2) emissions by 2035.

These ambitious targets require systematic climate action from us and our partners. Committing to climate targets has long-term impacts on our operations and requires a planned approach, as we make investments that serve our customers and society decades into the future.

We continue our work responsibly while listening to our customers

Through this development plan, we ensure that we at Elenia remain committed to developing our electricity network in a cost-efficient and responsible manner to meet the needs of our customers, stakeholders and society as a whole.

By building a smart and weatherproof electricity network, we support the smooth everyday lives of our customers, safeguard the security of supply for society, and contribute to enabling the energy transition in Finland.

Tommi Lähdeaho
COO

Elenia Verkko Oyj

Revenue
344,5 M€

Personnel
80

Market share
12 %

Customers
443 000

Electricity network
77 400 km

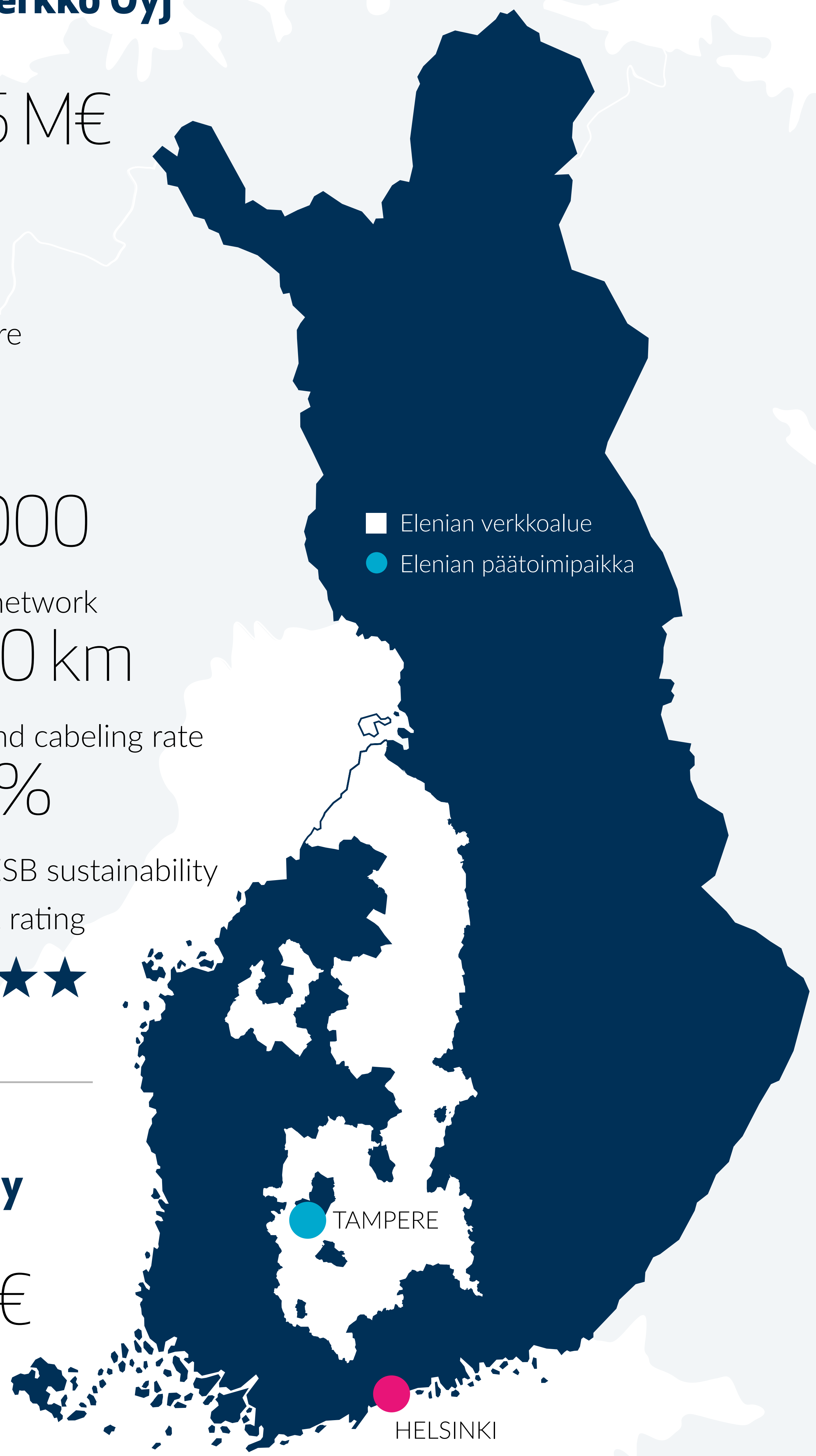
Underground cabeling rate
66,4 %

Global GRESB sustainability assessment rating
★★★★★

Elenia Oy

Revenue
7,4 M€

Personnel
220



General

Elenia's strategic choices and future plans for electricity network development are set out in the electricity distribution network development plan. The electricity network is part of critical infrastructure, and through its operations Elenia seeks to improve the security of electricity supply and to meet the capacity needs of both current and future customers. We have systematically improved the reliability of our electricity network since 2009 by upgrading it to be weatherproof. The development plan describes the measures which, once implemented, will ensure that by 2036 there will be no power outages exceeding 6 hours in zoned areas or 36 hours in sparsely populated rural areas as a result of storms or snow loads.

However, based on the results of the consultation conducted for the 2024 development plan, a 36-hour interruption does not meet the needs of an electrifying society. Of the respondents, 93 per cent considered that the maximum acceptable interruption length would be 12 hours or less, and as many as 60 per cent considered that a reasonable interruption would be 3 hours or less. To guide its own operations, Elenia has therefore, since 2009, voluntarily paid compensation for every outage exceeding six hours, regardless of whether the affected customer resides in a zoned area or in a sparsely populated rural area, and network development measures have been dimensioned to serve customer needs also over the long term.

Thanks to our investment programme, since 2025, 85 per cent of our customers have been within the scope of electricity distribution that meets the security of supply requirements of the Electricity Market Act, with 91 per cent of customers in zoned areas and 76 per cent of customers in sparsely populated rural areas covered by the quality requirements. Network renewal was initially initiated in areas with a high number of customers and services critical to society, and typically located near substations. As the sending ends of substation feeders, including densely populated areas, have been made weatherproof, the focus of network renewal has now shifted from zoned areas to sparsely populated rural areas. Significant further investments are still required to achieve the quality requirements in sparsely populated rural areas.

In addition to investments aimed at improving security of supply, enabling the clean transition by meeting the capacity needs of existing and new customers requires substantial investments, particularly in substations and the high-voltage network. Over the past two years, a significant number of new medium-voltage and high-voltage network connection requests for production, consumption and electricity storage facilities have been received. Although not all inquiries will materialise as connections, it is clear that there is an urgent need for network development.

Elenia's electricity distribution network development plan for 2014–2036 has been prepared in accordance with the structure set out in the Energy Authority's regulation on electricity distribution network development plans issued on 2 November 2023 (record number 3167/000002/2023). With the actions defined in the development plan, we ensure that Elenia's distribution network fulfils, in line with our criteria, the requirements laid down in sections 51 and 110 of the Electricity Market Act. Elenia has applied a network development plan in its operations since 2012, and the fundamental principles and strategy of the plan have not materially changed.

In accordance with the guidelines, the development plan has been divided into seven separate appendices, each presenting Elenia's responses, together with justifications, to the individual points set out in the annex to the regulation. The background materials describe, among other things, Elenia's operating principles and ongoing electricity network development projects. The documents attached to the development plan as background materials form part of Elenia's certified asset management system.

Sustainability and quality management systems

Sustainability is an integral part of Elenia's day-to-day operations. In recent years, we have taken significant steps in developing the sustainability of our operations. Elenia's first sustainability report was published in spring 2019 and the sustainability programme was launched in autumn 2019. The sustainability programme and the set targets guide our work systematically and purposefully. Our latest sustainability report can be found on our website.

Our operations are based on certified quality management systems. In 2014, our asset management system was certified in accordance with ISO 55001:2014. Elenia has a certified environmental management system (ISO 14001:2015), an occupational health and safety system (ISO 45001:2018, previously OHSAS 18001:2007) and an information security management system (ISO/IEC 27001:2013), which was certified in March 2020.

In 2018, we started the TEKO – Safely Back Home programme in which Elenia employees and contractor partners jointly committed to developing occupational safety so that everyone can return home healthy at the end of the day. Our goal is to make Elenia one of the world's safest places to work, so as a natural continuation, we have launched the TUISKU safety development project that takes safety practices, operating culture and common safety thinking even further based on the identified targets for development. In 2023, for example, best practices for field work were launched and a safety academy for Elenia employees and contractor partners was launched. In practical work, we conduct monthly monitoring and reporting of safety, environmental and information security incidents, proactive safety and environmental actions as well as the realisation of recycling.

The policies that guide our operations have been published on Elenia's website and can also be found in Appendices 1–5. The background materials also include more information about Elenia's existing and certified quality management systems. In addition to the above-mentioned documents, the most important documents complementing the electricity network development plan can be found in the background materials.

Elenia's strategic forecast of changes in the operating environment

1. Elenia's key indicators and forecasts for the future

This section presents the forecast for the development of the key indicators of the electricity network business over the next ten years. The forecast used is the forecast of rapid transition selected as the outcome result of scenario work. The forecast is presented in Table 1.

Table 1: Forecast for the development of the key indicators of the electricity network business over the next ten years

	Current state 31 Dec 2025	Forecast 31 Dec 2035
Energy transmitted in the network area, MWh		
1) Energy transmitted to network service customers	5,977,327	8,983,000
2) Energy received from network service customers	4,329,844	10,684,000
Number of metering points	443,299	459,000
Distributed generation		
1) Nominal power, kW		
1.1) Connected to the high-voltage network	1,476.500	3,347,000
1.2) Connected to the medium-voltage network	153,029	972,100
1.3) Connected to the low-voltage network	183,862	658,100
2) Number of production sites		
2.1) Connected to the high-voltage network	30	67
2.2) Connected to the medium-voltage network	103	151
2.3) Connected to the low-voltage network	19,692	39,947
Number of connections used in public charging of electric vehicles	300	638

2. Demographic development, electrification and renewable electricity production forecastst

In 2025, we once again updated the electrification scenario work originally carried out two years earlier, in cooperation with Vanguard Consulting Oy and Aki Toivanen. For the purposes of updating the 2026 development plan, the work focused in particular on the pace of the energy transition and on new electrification categories that have a significant impact on network capacity requirements. The framework of the scenario work follows the previous 2024 model, but the content has been updated to reflect the latest national forecasts and the results of the scenario analysis.

In the update of the 2026 development plan, the established scenario methodology was continued, with network capacity needs assessed by constructing several alternative development pathways. The scenarios were developed using official national statistics and sector-specific forecasts, which have been aligned with the national energy and climate strategy published in July 2025.

The key indicator forecasts are based on Finland's national development forecasts, which have been scaled to Elenia's network area. These forecasts form the basis for all of our development work:

Population development and households

- Finland's official municipality-specific population projections (Statistics Finland, latest release 10/2024)

Building stock and heating methods

- Building stock and heating method statistics by municipality (Statistics Finland, latest data from 2022)
- New measures and scenarios of national energy and climate policy (KEITO project, Ministry of the Environment and VTT, 2025)

Forecast of energy consumption in buildings

- Forecast model for energy use in buildings (VN TEAS HIISI WAM model, utilised in the 2025 KEITO project)

Decarbonisation of electricity production, industry and new technologies

- Fingrid's electricity system vision (Q3/2025), covering renewable generation, basic industries, data centres, Power to X projects and energy storage (batteries)

Home charging, fast charging and heavy-duty charging of electric vehicles

- Vehicle registration statistics (Traficom, Q1/2025 statistics)
- Traffic volume statistics by road and municipality type (Traficom, 2021)
- Forecast model for the electrification of transport (VTT Eliisa WEM P model, published in 2024, utilised in the 2025 KEITO project)

National governance and strategies

- National Energy and Climate Strategy (Ministry of Economic Affairs and Employment, published on 4 July 2025)
- EU legislative packages, such as Fit for 55 and the AFIR Regulation

Key changes in sources and focus

- **Population forecast:** Updated to the October 2024 forecast, which anticipates higher population growth in Elenia's network area than previously estimated, particularly in developing regions.
- **New categories:** Completely new categories have been introduced into the calculations, including data centres, the electrification of district heating, and energy storage solutions, all of which are assessed to have a significant impact on network capacity requirements.
- **Transport:** Transition to the updated VTT Eliisa WEM-P model (2024), which projects a slightly faster growth of the electric vehicle fleet up to 2040 compared to earlier forecasts.
- **Production and consumption:** Forecasts have been synchronised with Fingrid's 2025 electricity system vision.

In addition to national forecasts, Elenia's own studies, actual volumes, growth forecasts and expert opinions were used as background information.

Clean transition scenario alternatives

As an outcome of the work, four scenarios were developed, on the basis of which forecasts were prepared and impacts analysed:

1) **Slow transition**
- Electrification progresses more slowly than national targets

2) **Normal transition**
- Electrification development is based on national forecasts and follows a controlled electrification pathway.

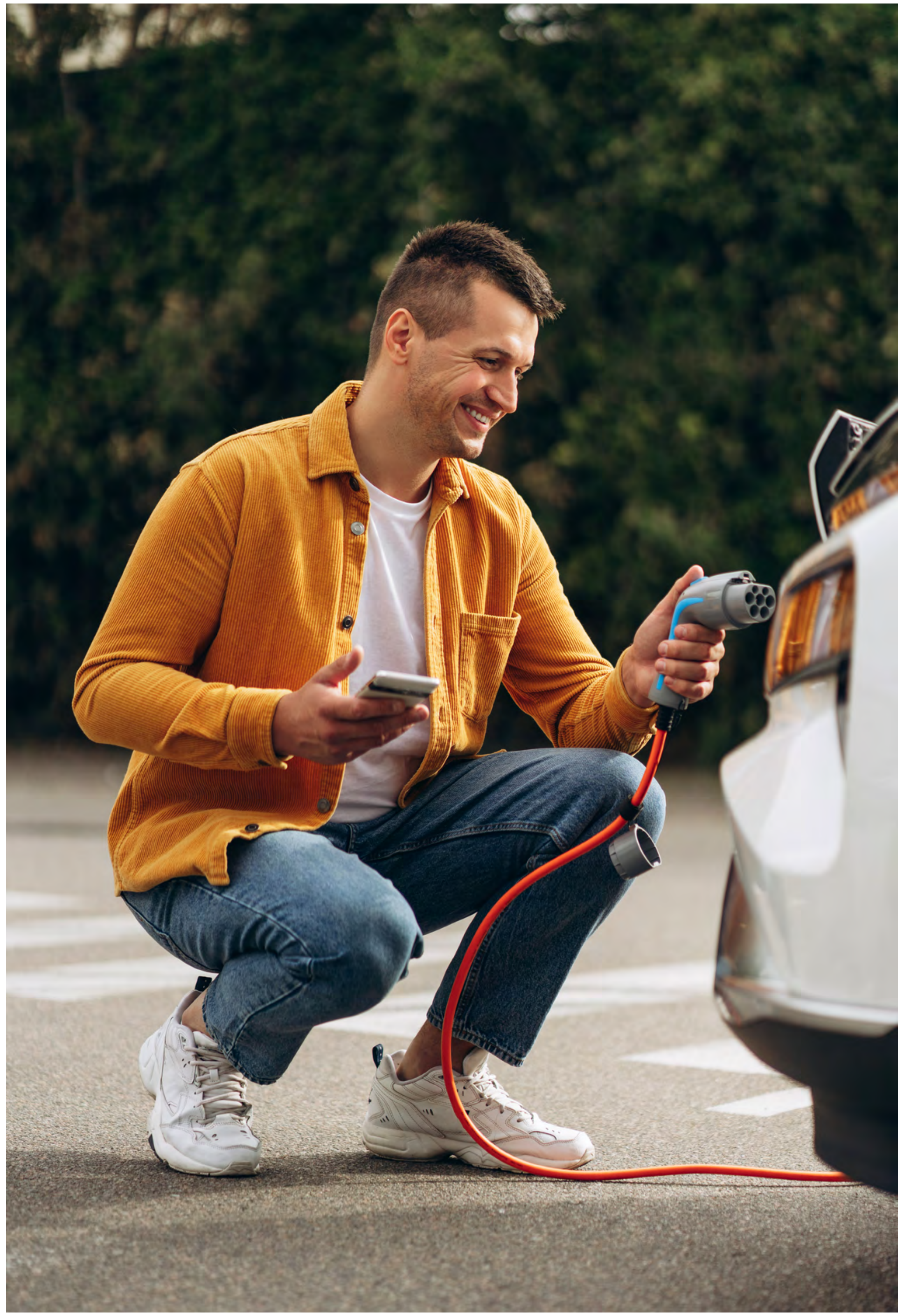
3) **Rapid transition**
- Electrification progresses faster than national forecasts and exceeds baseline projections, particularly with regard to new industrial sectors.

4) **Faster-than-national transition**
- Electrification progresses faster than national forecasts and exceeds baseline projections, particularly with regard to new industrial sectors.

Based on this extensive scenario work, historical data and recent observations, Elenia has decided to apply the **rapid transition scenario** in its electricity distribution network development plan.

Table 2: Key changes compared to the 2024 plan

Variable	Direction of change 2024 vs. 2026	Magnitude of change since 2024
Population	**Increased**	**Minor**
Building energy consumption	No change (excluding population)	Minor
Electric vehicles	Higher EV penetration	Minor
Small scale PV production	National estimates decreased	Minor
District heating electrification	Significant impact in 2020s	High
Basic industry	Increased forecasts in the scenarios	Moderate
Datacenters	Completely new components that were not directly considered before	High
Battery energy storage systems	Completely new components that were not directly considered before	High
Power-to-X	Completely new components that were not directly considered before	High
Renewable energy production	Sligthly increased estimates	Minor



[1] *Lassila, Jukka et. al. Joustava ja toimintavarma sähköverkko – Asiakaskatoriski ja käyttöpaikkakohtainen toimitusvarmuus.* Available here

Population development: The updated forecast (10/2024) projects higher population growth in Elenia's network area for growing and developing cities and municipalities than previously estimated, with a moderate impact on network capacity requirements.

New high-impact categories: Entirely new categories have been added to the calculations, including data centres, the electrification of district heating and energy storage solutions (batteries). Some of these categories were previously included under industrial electrification in the earlier development plan. They are assessed to have a significant impact on network development needs.

Industrial electrification: The impact of basic industry and hydrogen production is assessed to be greater than previously estimated, based on Fingrid's updated vision.

Connections and energy volumes: In particular, the number of high-voltage consumption connections and the total volume of energy transmitted are forecast to increase clearly compared to the 2024 plan.

Small-scale solar generation: The forecast has been slightly moderated compared to the 2024 plan, based on the latest market outlooks.

Elenia's view for energy transmitted in the network area

According to the rapid growth scenario, the gross consumption of electricity in Elenia's network area will increase by approximately 56 per cent in ten years. Electricity consumption will increase, in particular, by the electrification of energy-intensive industries, transport and heating. The processes that are electrified to reduce emissions from industry will increase electricity consumption most, according to estimates especially in chemical and food industries. Small industry is estimated to offer less potential as process electrification has already taken place there. In addition, more electricity will be consumed in the heating of homes when other fuels are replaced by heat pumps. Consumption is curbed by declining demographic trends, improved energy efficiency and volatile market prices of electrical energy.

Wind power capacity is expected to double and solar power generation to triple over the next ten years. Additional wind power capacity is expected especially in North Ostrobothnia and Central Finland but also increasingly often in other network areas. Our website features a map showing all completed wind farms connected to Elenia's network as well as wind farms under construction.

Population and Metering points

The updated forecast (10/2024) projects higher population growth than previously estimated for Elenia's growing and developing cities and municipalities. Population decline is expected to be particularly pronounced in Elenia's northern areas, while population growth is nevertheless assumed in the municipalities surrounding Tampere and Seinäjoki.

The connections to be dismantled are individual houses in sparsely populated rural areas and the new connections are often in terraced houses or blocks of flats in growth centres where the electricity connection consists of several places of electricity use. E-mobility and especially public charging stations will also increase the number of connections or, alternatively, existing connection capacity.

During the COVID-19 pandemic, we have witnessed the revival of rural areas as increasing new leisure-related Metering points and the re-activation of passive Metering points. This is believed to have impacts on leisure housing and multilocality. The number of inhabitants and Metering points are not decreasing at the same rate in different regions. A study by the Lappeenranta University of Technology[1] indicates that if the place of electricity use is located near a body of water, it is more likely to remain in use. Elenia's own findings support the findings of this study.

Population decline in Elenia's network area does not directly mean that the number of customers, i.e. the number of Metering points, would decrease. According to our estimate, there will be no major changes in the number of Elenia's metering points over the next ten years.

Industrial-scale electricity storage and home batteries

Industrial-scale electricity storage systems have been a dominant theme in new connection inquiries and concluded agreements within the corporate customer segment. In 2025, industrial-scale electricity storage was the largest category in terms of the number of connections sold. The market is expected to grow in line with national forecasts, with growth anticipated to be concentrated particularly in high-voltage battery systems, which is reflected in an increase in average project size.

Home batteries are being connected to the electricity network at a steady monthly pace, and there are currently approximately 1,200 units in operation within Elenia's network area. With a probability of more than 80 per cent, home batteries are installed at sites that already have a solar power system. This improves predictability and facilitates the assessment of network impacts, as the load and generation profiles are typically better known. We estimate that the adoption of home batteries will follow a development path similar to that previously observed for solar panels: an initial phase of steady growth, potentially followed by accelerated uptake as costs decline and availability and user experience improve.

Electrification of transport

In July 2021, the European Commission published the Fit for 55 package of proposals for climate change legislation to help the EU achieve a 55-percent reduction in net emissions by 2030. The package contains 13 legislative proposals. The Alternative Fuels Infrastructure Regulation, aiming at the reduction of emissions from transport, provides distribution system operators with a framework for the development of the future electricity network.

The Regulation contains requirements for different charging speeds and vehicle types, specified by road type. The Regulation discusses the TEN-T core network, which in Finland means 1,100 kilometres of road: roads 4 and 5 from Helsinki to Jyväskylä and via Oulu to Tornio and the West-East road connection from Naantali to Vaalimaa. More than 200 kilometres of road 4, belonging to the TEN-T core network, is located in Elenia's network area. Practically all Finnish roads with numbers consisting of one or two digits belong to the TEN-T comprehensive network. Hundreds of kilometres of roads belonging to the comprehensive network are located in Elenia's network area.

Home and in-station charging

By 2035, the target for electric vehicles in traffic in Finland is more than one million fully electric cars and more than 350,000 plug-in hybrids, which corresponds to about one-half of Finnish cars. We estimate that about 14 per cent of these cars will be connected to Elenia's network area with steadily accelerating growth.

Elenia has made a calculator for customers to check how much available capacity the connection has for electric vehicle charging devices. Dynamic load management devices are also commonly used to make more efficient use of customers' connection capacity.

The increasing use of home and in-station is challenging the capacity of the distribution network due to the increased use of exchange electricity, as consumption is allocated to the same low-cost hours.

Fast charging and heavy-duty charging

Along the TEN-T core network, there must be public charging pools for passenger cars with a maximum distance of 60 km between them. By the end of 2025, each charging pool must offer a power output of at least 300 kW and include at least one charging station with an individual power output of at least 150 kW. By 2030, each charging pool must offer a power output of at least 600 kW and include at least two charging stations with an individual power output of at least 150 kW.

The TEN-T comprehensive network must have public charging pools at the same intervals as the core network. The power outputs of charging pools and individual charging stations are also subject to equivalent requirements, but the schedule is set 5 years later than in the core network area.

Considering the current situation, the requirements seem to be very appropriate and the market is naturally guiding the development in this direction. The power required for charging passenger cars is not a major challenge for Elenia's network. However, it must be taken into account in the electricity network development plan.

Along the TEN-T core network, there must be public charging pools for heavy-duty vehicles with a maximum distance of 60 km between them. By the end of 2025, each charging pool must offer a power output of at least 1,400 kW and include at least one charging station with an individual power output of at least 350 kW. By the end of 2030, each charging pool must offer a power output of at least 3,500 kW and include at least two charging stations with an individual power output of at least 350 kW. In the TEN-T comprehensive network, the requirements for public charging pools are equivalent but the schedule is set 5 years later than in the core network area. In addition, charging requirements are proposed for the parking and rest areas and urban nodes for heavy-duty vehicles. The proposed power output requirements are 100–150 kW for one charging point and 100-1,200 kW as the total power output but the proposals do not include a guideline for the distance between charging facilities.

At the moment, the proposal for heavy-duty vehicles seems ambitious in the Finnish operating environment as the electrification of heavy traffic has not started in the same way as for passenger cars. Electrification has started from the short-distance fleet such as urban bus transport and delivery trucks. This is still a long way from the electrification of the long-distance fleet, which requires efficient charging pools and the electrification of rest areas. As the electrification of heavy traffic becomes more widespread, it will require significant network development as the distribution of several megawatts over the medium-voltage network is not a sensible option or even possible over long distances.

3. Impact of weather events and changing climate on Elenia's electricity network

Elenia's electricity network is geographically very extensive, spanning approximately 600 km in the north–south direction and 200 km in the west–east direction in eight provinces from Hailuoto to Karkkila. The network area is mainly forested and lake regions of Finland. The geographical location, altitude differences, the abundance of forests and lakes and the short distance to sea areas expose the electricity network to various strong weather events. On the basis of history and statistics, it can be said that Elenia's electricity network is geographically located in the area that is the most susceptible to major power disruptions in Finland.

Elenia has compiled detailed documentation about the impacts of major weather events on its operations. During this decade our electricity network has been subject to 19 major power disruptions and numerous minor disturbances due to low-pressure storms, thunderstorms and snow loads. Contingency planning has been initiated tens of times during the above-mentioned period. Major power distribution disruptions have occurred at a steady rate each year and this can be expected to continue.

Extreme weather events are causing power outages, which may last for several days, to customers in Elenia's electricity network. The most significant storms were Jari in November 2024 and Hannes in December 2025. The latter was the most severe major disturbance in Elenia's network area in 14 years, resulting in more than 3,000 fault repair tasks and with the longest power outages lasting for over a week under winter conditions. During both storms, the ground was unfrozen and highly saturated due to heavy rainfall.Elenia's strategy for meeting the security of supply requirements of the Electricity Market Act has, since the entry into force of the Act, been extensive underground cabling of the medium-voltage and low-voltage networks. Although the numbers of fault incidents during the Jari and Hannes storms were record-high, they were concentrated in the remaining overhead line network, while the underground cable network practically suffered no damage. This confirmed that Elenia's chosen strategy is effective and should be continued.The underground cabling target for 2036 is 90 per cent, at which point only isolated branches of medium-voltage overhead lines will remain, and their repair within 36 hours will be feasible.

According to the Finnish Meteorological Institute's estimate, the intensity and number of storms, as such, will not increase but their impacts will become more significant, especially when it comes to soil frost and rainfall. The ground will be more wet due to higher rainfall and higher temperatures during the winter months, which prevents the formation of soil frost. Due to these factors, roots do not provide trees with as good protection against falling due to wind as before. Rainfall will increase also in the winter period and will be more intense both locally and temporally, resulting in higher occurrence of heavy snow loads. The above conclusions are also supported by the Finnish Climate Change Panel's report 2/2021, "Ilmastonmuutokseen sopeutumisen ohjauskeinot, kustannukset ja alueelliset ulottuvuudet"[2] (Steering measures, costs and regional dimensions of climate change adaptation) and the Finnish Meteorological Institute's webinar on storm Hannes in March 2026. According to these sources there will be a decrease in the amount of soil frost and increase of rainfall throughout Elenia's network area leading to a higher risk of wind-induced damage in the future.

Based on regional risk assessments prepared in 2023,[3] storms, floods, forest fires and other extreme weather events are seen as potential risks in Elenia's network area. Because the overwhelming majority of power outages experienced by customers are caused by weather events and natural phenomena, it is expected that there will be more disturbances in the overhead line network due to climate change. In addition, the costs caused by faults in the electricity network and major power disruptions are significant, as contingency planning, electricians and special equipment are needed regardless of the season or the time of day.

[2] *Gregow, H; Mäkelä, A et. al. Suomen Ilmastopaneeli raportti 2/2021)* Available here

[3] *Regional risk assessments* Available here

4. Development of the operating environment over the next 10 years

This section presents other operating environment changes over the next ten years, as identified by Elenia.

Regulatory environment uncertainty

The electricity distribution regulatory methods in force since 2024 contain more uncertainty factors from the perspective of distribution system operators than previously. The freezing of the asset base and the retroactive determination of unit prices make the profitability of investments more uncertain. In addition, changes made by the regulatory authority during a regulatory period to the calculation of allowed returns, as well as requirements for the preparation of the unbundled balance sheet that deviate from previous practice, further increase uncertainty.

Uncertainty in the regulatory environment complicates longer-term planning of network development and may lead to situations where investment plans need to be revised at short notice. Elenia has made significant investments using market-based external financing. However, the use of debt financing has its limits and cannot fully compensate for the shortfall in income generation caused by the regulatory methods. If the regulatory methods remain unchanged, Elenia considers it likely that, over the longer term, the company's revenue generation will not be sufficient to cover all necessary investments related to security of supply and network capacity.

Capacity situation and customer needs

The impact of the energy transition is clearly reflected in electricity network connection inquiries, the volumes of which have remained high over recent years. Not all inquiries materialise as connections, but during the previous development plan period of 2024–2026, more new medium-voltage and high-voltage network connections have been sold than the corresponding increase in capacity achieved through investments. This has gradually led to capacity constraints, particularly in the vicinity of growth centres, as the investment cycle of the electricity network is inherently long. For example, the delivery time of a 110/20 kV main transformer can exceed two years, meaning that network development should take place proactively to prevent capacity shortages from worsening. This is not always feasible, as demand is distributed widely across the network area and the precise locations of new connections cannot always be anticipated in advance. Even when there is preliminary information about needs, uncertainties in the regulatory environment require distribution system operators to carefully assess investment decisions, and capacity expansion investments are therefore not made without reliable information on realised customer demand. As a result, a gap emerges in which new capacity cannot be added to the network at the same pace as it is sold.

In the case of medium-voltage connections, one key limiting factor is the main transformer at the substation. Table 3 illustrates the loading situation of Elenia's main transformers in spring 2026. The table shows that more

Table 3: Primary transformers' loading

Explanation	Entire network area
Primary transformers in total	169 pcs
Primary transformer loading less than 50%	48 pcs
Primary transformer loading 50-70%	61 pcs
Primary transformer loading over 70%, only limited capacity to be sold	45 pcs
Primary transformer out of capacity	15 pcs
Primary transformer capacity in total	3230.5 MVA
Primary transformer available consumption capacity	941.3 MVA

than two-thirds of the main transformers are already loaded above 50 per cent. Correspondingly, capacity is fully utilised—or only limited additional capacity remains available for sale—in every third main transformer. The shift from a favourable capacity situation to an alarming one has occurred in practice over the past two years.

In the high-voltage network, the situation is not yet as critical, but particularly on the consumption side, an increase in the power requirements of projects is clearly visible. As a result, even individual connections may consume a significant share of the available capacity of a high-voltage line. At the same time, Elenia is always dependent on the capacity of the connection points to the transmission system, and as Fingrid is facing similar capacity challenges, it is not always possible to connect customers even if capacity is available within Elenia's own network.

In Europe and nationally in Finland, flexibility solutions have been identified as one tool for alleviating capacity constraints. Elenia has therefore examined the applicability of various flexibility solutions and views their implementation primarily as a potential opportunity. However, the capacity situation is already critical, and capacity flexibility services suitable for distribution system operators are still at an early stage of development. Moreover, for example in the case of open-ended connection agreements, the network must ultimately be developed to meet the customer's capacity requirements regardless of any temporary flexibility provided by the customer. Flexibility can thus create temporary breathing room and reduce peak loads, but the final solution is always network development.

Elenia seeks in every way to serve its customers and to ensure smooth access to the network for applicants who meet the requirements. However, network capacity has diminished faster than it has been possible to respond through investments. The development plan describes the need for network development from an asset management perspective, and the rapid progress of the clean transition has been recognised and is being addressed. Nevertheless, it is possible that the need for capacity investments will prove to be even greater than currently estimated. At the same time, sufficient capacity and the investments required to secure it are of fundamental importance for the security of supply.

Customers' zero-emission expectations

Customer expectations regarding responsibility have strengthened, and carbon neutrality has become a key criterion in the assessment of energy sector operators. Consumers, businesses and public-sector actors alike expect distribution system operators to demonstrate tangible sustainability actions, transparent operations, open communication and an active role in the green transition of the energy system. Customers' growing awareness of climate change is reflected in expectations that extend beyond security of supply to include emissions reductions and the minimisation of environmental impacts.

We have set the targets for reducing the greenhouse gas emissions of our own operations in accordance with the Paris Climate Agreement, and the international Science Based Targets initiative has validated Elenia's climate commitment. According to the validated target, Elenia will reduce its greenhouse gas emissions by 42 per cent by 2030, including Elenia's own emissions and emissions arising from purchased energy. The target that we have set for ourselves is even more ambitious in this respect: Reducing the emissions of our own operations by 75 per cent, using 2020 as the baseline, by 2030.

In addition, Elenia is committed to setting Net Zero targets that cover not only the emissions from Elenia's own operations but also the emissions generated by the entire value chain. The Net Zero targets must be met by 2050 and in practice this means a reduction of approximately 90 per cent in emissions for the company's entire value chain. For Elenia, this means that climate targets will not only be pursued in the company's own operations but also incorporated into procurement decisions. Low-emission requirements apply to the purchasing of energy to cover network losses as well as to the contracting and maintenance purchases of network construction. The purchase of materials for the electricity network, in particular the underground cable supply chain, also plays a significant role. By committing to climate action, we respond to the increasing expectations of customers and society with regard to combatting climate change, and we want to lead the way for the whole industry.

Expectations regarding carbon neutrality have strengthened among corporate customers, particularly in industry and among large energy users. Industrial actors report on their own climate targets and require transparency from their energy supply chains, as well as evolving solutions that support their own Net Zero pathways. The smooth implementation of carbon free connection solutions, sufficient network capacity, and the ability to generate or store energy within the network without bottlenecks have become increasingly important expectations.

At the same time, expectations among consumer customers have become more diverse. Customers value clear and transparent information about their own electricity consumption. Responsibility and the consideration of environmental impacts are reflected in particular in expectations related to digital services, where customers seek up to date information, predictability and solutions that reduce the environmental footprint of everyday life.

Elenia's own climate targets, emissions steering across the procurement chain, and the transparent emissions information provided to customers directly address these expectations. By committing to ambitious emissions reductions, Elenia operates in line with the expectations of both its customers and society at large and strengthens its role as a forerunner within the sector.

Partnerships and competence needs

Elenia's operations and service production are based on versatile partner networks. As a network builder, Elenia Group purchases network construction and maintenance services from the open market. The Group companies do not have their own installation operations or ownership stakes in the service market. In cooperation with our partners, we have created a solid foundation for well-functioning services. Our model has proven to be effective in customer projects, investment projects, network maintenance and exceptional situations caused by power outages.

Maintaining the functionality and competence of the partner network is of paramount importance from the point of view of security of supply, which is described in more detail above. As power outages caused by storms and snow loads cannot be completely eliminated, we are constantly developing efficient fault repair operating models with our partners to ensure security of electricity supply. The operating models are finetuned to be as effective as possible and they can be used in day-to-day operations in the event of extreme weather phenomenon/condition but they also guarantee our ability to respond to other crises. Competence associated with making repairs to the overhead line network will be a challenge for the entire industry as investments are justifiably focused on the underground cable network while overhead line experts retire. Future investment conditions should be favourable in order to also secure the availability of skilled electrical installation resources during storm damage events and other crisis situations. Ensuring sufficient availability of qualified electricians under normal operating conditions requires an adequate and sustained level of network investments, so that employment opportunities and the year-round availability of installers can be maintained in all circumstances. In addition, this enables network construction companies to utilise, for example, apprenticeship training schemes to ensure the continuity and development of professional competence.

The role of digital systems is growing and, as a result, new skills are required from network technicians. An increasing amount of real-time information is produced on network development and maintenance, enabling better service to network users. Customer expectations regarding service provided to them will increase in the future, which will require better customer service skills from network technicians, too.

Cyber security requirements

Cyber security requirements have continued to increase, and in light of the global situation and rapid technological development they are expected to become even more stringent. Geopolitical instability has raised the risk classifications for cyber threats targeting critical infrastructure both at EU level and nationally, and political tensions are expected to persist in the near future.

From a technological perspective, the use of artificial intelligence and automation in cyber attacks has, as anticipated, become commonplace. In particular, the speed at which so-called zero-day vulnerabilities—new security gaps—are exploited has increased, and is expected to continue increasing. The Finnish language has previously reduced the success rate of fraudulent attempts by international actors aimed at system users, but with AI this advantage is increasingly disappearing. At the same time, energy markets and electricity distribution are becoming ever more dependent on digital solutions, an almost real-time situational awareness of the network, and the ability to adapt flexibly to fluctuating consumption and production conditions. Accordingly, the effort required to maintain the software of devices containing digital components, as well as the investment needed in personnel competence, has increased steadily in recent years and is expected to continue to grow in line with the developments described. The timeline for the broader adoption of quantum computing remains uncertain, but a commercial breakthrough would also create significant pressure for change in digital solutions used in electricity distribution.

Geopolitical uncertainty, combined with generally increasing cyber security requirements, underscores the importance of digital resilience and continuity exercising. The broad range of threat scenarios requires increasing investment in identifying different scenarios and practising responses to them—from combined physical and cyber threats posed by state actors to attacks by criminals seeking financial gain.

At the company level, our operations will continue to be strongly guided by the ISO/IEC 27001 information security management system certified since 2020. Cyber security risk assessment, the implementation of controls and the continuous development of operations are part of everyday work, supported by an externally certified management system. As a result, compliance with other requirements, such as NIS2 and NCCS, is also smooth. EU-level and national cooperation, information exchange and preparedness exercises with both authorities and other critical infrastructure operators are active, and are expected to remain active in the future as well.

Security of supply and preparedness

All major recent military conflicts and other significant crises have demonstrated the central role of the energy system in maintaining the functional capacity of society and its citizens. In military conflicts, the energy system has repeatedly been a key target, as disrupting it directly affects the opposing party's ability to defend itself or to maintain critical societal functions such as telecommunications, water supply and public authority services.

Through long-term investments in the electricity network, we can improve not only the everyday quality of electricity distribution experienced by customers, but also the operational resilience of the system in exceptional circumstances. By investing in the network to increase distribution capacity, establish backup connections and connect new generation customers, for example, the system becomes more decentralised and therefore more resilient to disturbances. Through investments, we also maintain the supply chains that provide the resources required for fault repair, the spare parts supply chain, the equipment needed for reconstruction and efficient operating models. This structure supports operations both under normal conditions and in emergencies. A high level of security of supply is based on sufficiently proactive and timely network development. Regulation that weakens investment certainty therefore also increases uncertainty from the perspective of safeguarding security of supply.

Preparedness and contingency plans are key tools for Elenia in ensuring security of supply and preparedness. These plans are utilised in crisis situations and guide Elenia's preparedness activities. Elenia updated its preparedness and contingency plan in spring 2025. At the same time, a preparedness self-assessment was conducted and, based on it, a preparedness development plan for 2026–2028 was prepared. The plans and self-assessments were submitted to the Energy Authority for review in summer 2025.

A comprehensive reform of the Emergency Powers Act is currently underway, and the entry into force of the new legislation is expected within the next year. Following the update of the Act, Elenia's contingency plan will be revised to comply with the new requirements, and the relevance of the preparedness development plan will be reassessed at the same time.

Over the next two years, our focus will be on intensive training for operating under emergency conditions, developing solutions to protect the electricity network, familiarising ourselves with the requirements of the new Emergency Powers Act, actively participating in security of supply cooperation, and strengthening staff awareness and competence in preparedness matters.

Elenia cooperates extensively and continuously on security of supply both regionally and nationally. We participate in numerous industry working groups, take part in various preparedness and contingency exercises, and familiarise our stakeholders with issues related to security of electricity supply and preparedness for power outages. Lessons learned and information gathered from Ukraine have also been taken into account. Elenia has a steering group responsible for coordinating preparedness and security of supply matters, which meets regularly.

5. Amendments to the 2024 development plan

Elenia submitted the previous electricity network development plan to the Energy Authority in June 2024. At that time, the investment need required by the clean transition was, for the first time, identified at its full scale, and Elenia's total investment requirement increased to EUR 2.4 billion for 2024–2036, compared with EUR 2.0 billion for 2022–2036 in the preceding development plan. The total investment requirement covers all investments in Elenia's electricity network, including replacement investments aimed at improving security of supply and safety, expansion investments driven by the capacity needs of new loads and generation, as well as new electricity meters and new connections for small customers which, in accordance with the Energy Authority's regulation, are not reported in the development plan but nevertheless fall within the statutory responsibilities of a distribution system operator.

Compared with the previous development plan, the assessed investment need has continued to increase. Elenia's total investments for 2026–2036 amount to EUR 2.3 billion, meaning that the investment requirement over the review period has increased by nearly EUR 300 million compared with the 2024 plan. In order to comply with the quality requirements of the Electricity Market Act, Elenia has consistently followed its selected long-term strategy, and no significant changes have occurred in security of supply investments. By contrast, capacity shortages are challenging distribution system operators collectively, and new investments are increasingly targeted at capacity-related investments.

Within the assessed capacity requirements, the emphasis has shifted from the low-voltage and medium-voltage networks towards substations and power lines. In the previous development plan, reinforcement needs in the low-voltage network were assessed to be significantly higher, but improved modelling tools have now made it possible to scale this estimate downwards. Similarly, forecasts and network impacts related to small-scale generation, particularly solar power, have been revised downwards. It is, however, evident that customers who invested in solar panels in previous years are now installing home batteries. From the perspective of network impacts, home batteries can be even more challenging than solar generation, as batteries both charge and discharge power and are operated based on market signals. As a result, the combined effect of multiple batteries within the same transformer area may lead to significant loading.

By contrast, electricity storage systems at higher voltage levels and the electrification of heat production were underestimated in the 2024 development plan. Electricity storage systems are being connected independently with dedicated connections near substations, and electric boilers are being procured both for district heating production and for industrial use. The implementation schedules of battery storage and electric boiler projects can be very rapid, while their power demand—and thus their network impacts—are substantial. In addition, connection inquiries from data centres have emerged as a new category. These typically involve power demands that may be even higher than those of electric boilers, while exhibiting a more stable consumption profile. As a result, data centres are expected to require significant reinforcement of the network. Electrification of transport has progressed largely in line with forecasts, both for heavy-duty transport and private vehicles.

The connectability of Elenia's network is further challenged by capacity constraints in the transmission grid. In many parts of Elenia's network area, electric boilers and electricity storage systems have already consumed virtually all available transmission grid consumption capacity. No immediate relief is anticipated, but cooperation with the transmission system operator Fingrid regarding transmission grid investments to increase capacity has been constructive and effective.

To address capacity needs, the network must be expanded, and a larger asset base also implies increasing maintenance requirements. Compared with the previous development plan, the annual volume of maintenance has been increased, taking into account in particular new substations and power lines.

Starting point for the electricity distribution network development plan

Defining the electricity distribution network development zones

We have divided Elenia's electricity network into seven development zones, each of which is a separate entity in the development plan. In the division of the development zones, attention has been paid to the operational quality requirements in accordance with section 51 of the Electricity Market Act, the topology of the existing network and the target-state network as well as geographical characteristics. The development plan's cost comparisons and selected actions, together with their schedules, are presented separately for each development zone. Each part of the network belongs to a single development zone.

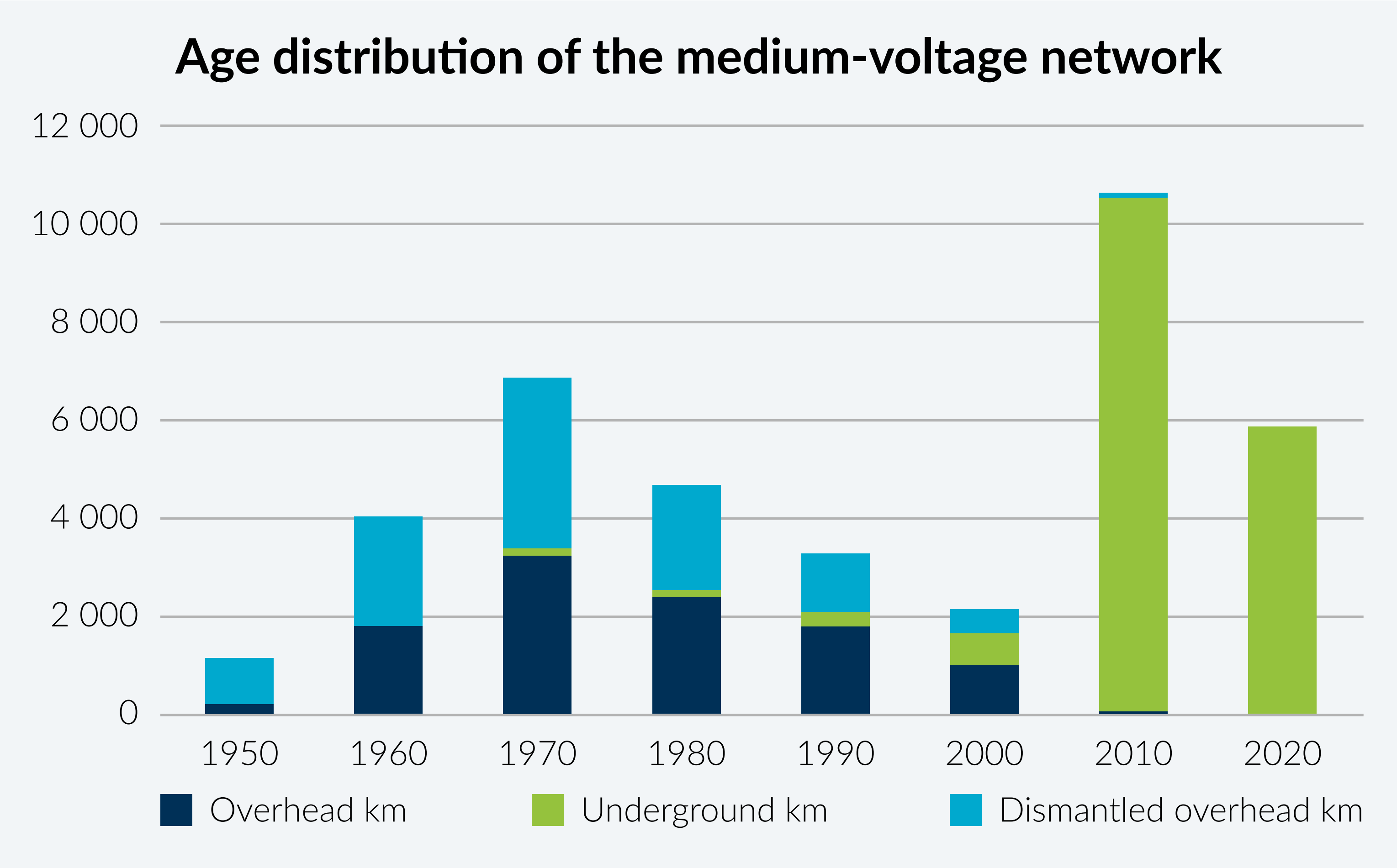


Figure 1: Age distribution of the medium-voltage network by decade

The age and condition of Elenia's electricity network varies a great deal, and the network is spread over a very large geographical area and is subject to different conditions. The age distribution of the medium-voltage network is shown in Figure 1, indicating that there are still a lot of ageing overhead medium-voltage network left. Since 2010, we have been upgrading significant amounts of aging overhead line network. The age distribution of the overhead lines dismantled in connection with the upgrading is also shown in the figure.

Due to the extent of our network area, we have considered it appropriate to divide our network into several parts so that each development zone becomes a manageable entity and that cost comparisons and actions can be justified with sufficient precision.

Our seven distribution network development zones are:

1. Urban areas
2. Densely populated areas
3. Trunk line connections between densely populated areas
4. Trunk line connections in sparsely populated rural areas
5. Spur line (furthest parts of the network) in sparsely populated rural areas
6. Overhead line network to be maintained in sparsely populated rural areas
7. Flexibility solutions for the security of supply

As the high-voltage distribution network extends into nearly all of these development zones, it is treated as an entity separate from the development zones.

Modern information systems, automation and smart metering devices play an important role in the monitoring, maintenance and development of Elenia's electricity network and in the management of fault situations. The

strategic development of this whole is a prerequisite for efficient and timely action now as well as along with the changes in the electrification of society described in section 1. The development plan describes actions that encompass the entire network area regarding information systems, automation and smart metering devices, and it is not meaningful to divide these actions by development zone. Attachments 12-16 to the background material present Elenia's strategies for network development, maintenance management, procurement and operation.

Description of the development zones

Information systems, automation and smart metering devices

Achieving the security of supply targets does not only require traditional network investments, but also efficient use of the electricity network and fault management. In Elenia's electricity network, efficiency has been increased especially through the use of automation devices, smart metering devices and information systems. At the beginning of 2026, Elenia's network already features over 11,000 remote-controlled switchgear devices and almost 5,000 fault indication devices. In addition, we have made long-term investments in advanced substation protection device technology. These technologies, combined with partially autonomous information systems that efficiently combine data, create a comprehensive overview of the situation and guarantee the efficiency of our operations. In practice, in the event of a fault in the electricity network, this enables the restoration of electricity supply to over 80 per cent of the affected customers on average in less than 15 minutes with the aid of remote-controlled switchgear and electricity network stand-by supply connections. Together with our contractor partners and information system suppliers, we have also actively developed information systems that make field work more fluent, with the aim of speeding up and enhancing final fault repair and power recovery for customers affected by outages. We continue to increase the automation of our electricity network as part of the electricity network investments, taking into account the requirements and characteristics of the different development zones.

Smart metering devices have been part of Elenia's operations for more than a decade. Their features have been used not only to meter customers' consumption of electrical energy but, in particular, also to manage electricity network faults and support investment planning. The installation project of the new generation of metering devices, which began in 2021, is now finalized, as most of Elenia's customers had already received a new electricity meter in 2025 and last installations will be carried out during 2026. These metering devices enable many new energy management features that are offered directly to the customer. For example, the customer can schedule the load control relay in the meter to turn on the water heater or other device of their choice at the lowest-priced exchange electricity hours of the day or monitor their electricity consumption in almost real time. Next-generation smart electricity meters and the services they make possible are a significant leap in the energy transition.

According to clean transition forecasts, renewable energy production will increase at all voltage levels. The increase in weather-dependent production and, on the other hand, fluctuations in consumption make the operation of the electricity network increasingly challenging. On the other hand, an increasing volume of real-time data is available from the network, which can be used in network monitoring and preventive maintenance, and the resulting data can even be used to identify incipient power grid faults. However, the management of the new kind of electricity system required systems to help people. Elenia is actively developing operational systems to respond to these challenges.

High-voltage distribution network

Elenia's 110-kilovolt high-voltage distribution network is scattered throughout Elenia's network area and does not constitute a coherent entity. Elenia also has numerous power line connections directly to the network of the transmission system operator Fingrid. Our website features a map where you can see Elenia's high voltage distribution network and the [wind power generation] connected to it.

Technical characteristics of the high-voltage distribution network

The majority of Elenia's high-voltage distribution network is located in sparsely populated rural areas and consists of overhead lines. The network has a partly looped structure but is used as a radial network. The operational reliability of branch lines in the high-voltage distribution network is secured with medium-voltage stand-by supply connections. Previously, network capacity was determined on the basis of the use of electricity in sparsely populated rural areas since electricity consumption needs have traditionally been very stable and power levels moderate.

The fact that the network is located in sparsely populated rural areas makes it possible to build the high-voltage distribution network mainly as overhead lines. In urban and densely populated areas, the high-voltage distribution network is also built with underground cabling, on a case-by-case basis.

Impacts of operating environment changes on the high-voltage distribution network

As a result of the energy transition, power demand in the high-voltage network in particular has increased significantly on both the consumption and generation sides. This has necessitated a revision of the dimensioning principles applied to new and refurbished network assets, in order to comprehensively meet customers' power requirements. Changes in the operating environment of the high-voltage distribution network are contemplated in close cooperation with the transmission system operator Fingrid, other high-voltage distribution network operators and customers.. The increasing volume of renewable energy production will require investments in the high-voltage distribution network, including parts of the network, where there would not have been otherwise a need for investments in such a fast schedule or on such a large scale. Energy intensive industry is expected to be located in industrial areas situated near growth centres, and in addition, project developers are actively seeking potential locations for data centres. All of these developments require an increase in the capacity of the high voltage distribution network as well as improvements in the security of electricity supply. In addition, the requirements for heavy traffic charging infrastructure laid down in the European Union's Fit for 55 climate legislation proposal will put pressure on the high-voltage distribution network and the capacity of main transformers will need to be increased in some substations.

1. Urban areas

Urban areas consist of the zoned central areas of larger cities, which are either clear grid-plan areas or otherwise very densely built urban environments. At the moment, such areas in Elenia's network area are the grid-plan areas of Hämeenlinna and Heinola city centres. According to section 51 of the Electricity Market Act, after 2036, the maximum allowed power outage in this development zone is 6 hours.

Technical characteristics of the development zone and the use of electricity

In urban areas, the electricity network is densely built and distances are short. The area's electricity network has been built as an underground cable network already decades ago, and consequently, some of the structures have already exceeded their useful life. Because the area is densely built, many transformer substations have been and will continue to be placed inside properties as indoor secondary substations. Due to alterations and changes made over the years, the age structure of the electricity network is very varied.

The electricity network of the development zone is looped and at least two alternative feed directions are built for all transformer substations. In maintenance and fault situations, this allows electricity distribution from an alternative direction. The low-voltage network is also extensively built with underground cabling as a ring network to support the replacement of a single distribution transformer in maintenance and fault situations.

In urban areas, the energy and power intensity is high. Buildings are usually heated by means other than electricity.

Environmental factors in the development zone

Urban areas are characterised by a very dense building stock and public areas are almost entirely paved or asphalted, with large numbers of people moving around. There is also plenty of other underground infrastructure in the area. For these reasons, it is not possible to carry out major construction projects; instead, infrastructure is built and upgraded a little at a time in order to minimise the inconvenience caused. In construction projects, it is important to replace the entire infrastructure of the project area as joint construction in order to minimise the inconvenience in a single area during the project. The upgrading of indoor secondary substations is primarily carried out in cooperation when the buildings are renovated.

The zoning of the areas sets strict requirements for how the electricity network can be built and what kind of structures are allowed: cables must be underground and transformer substations must mainly be placed inside properties as indoor secondary substations. Due to the building density and lack of space in public areas, cables are often placed in the street area and even in street structures, in which case the cables must be protected by placing them in pipes or canals. Another consequence of the building density is that in connection with earthworks in the development zone, it is not possible to deposit removed soil on the site; instead, it must be transported away from the site and then back again.

Impacts of operating environment changes on the development zone

The car fleet and heating in the development zone will be electrified, which will pose a challenge to the current connection capacity of housing companies and electricity network of the property, which is owned by the customer. The municipalities surrounding the growth centres in Elenia's network area, especially in Pirkanmaa, are becoming more densely built and, therefore, it can be expected that these areas will meet the definition of an urban area in the future.

Solar power generation in urban areas is expected to increase moderately. It is likely that electricity is consumed near small-scale production, which means that energy distribution distances are short and technical challenges do not emerge in the distribution network.

2. Densely populated areas

All zoned areas outside urban areas, apart from areas zoned with detailed shore plans, are considered densely populated areas. The areas are clear-cut and manageable but their size and shape vary highly/widely . At the smallest, the areas consists of only a few real estate properties or even just one but, at the largest, they cover an area of several square kilometres or form ribbon-like areas extending over several kilometres. Typically, the areas are also developing intensively. Land use develops within the areas and they also usually expand through the implementation of new zoning. According to section 51 of the Electricity Market Act, after 2036, the maximum allowed power outage in this development zone is 6 hours.

Technical characteristics of the development zone and the use of electricity

The electricity networks of densely populated areas have been built over time, using different principles and structures and in many places as a mixed network. The overhead lines of the mixed networks have mainly been replaced with underground cables, at least for the medium-voltage network, over the last ten years.

Kiosk-style secondary substations are commonly used in densely populated areas. Especially in the old network, there are also individual indoor secondary substations which are replaced, as far as possible, with kiosk-style secondary substations.

The medium-voltage network in densely populated areas has been built with underground cabling starting from the feeding substation and as a ring network. The low-voltage network has been built with underground cabling, partially as a ring network, and the connectivity of reserve capacity has been taken into account in the low-voltage network structures. A single transformer area can be replaced with a combination of stand-by supply connections and reserve capacity in potential maintenance and fault situations.

The energy and power intensity of the areas varies but is rather high, especially in industrial areas.

Environmental factors in the development zone

The areas have a fairly dense building stock but, as a rule, transformer substations can be built as kiosk-style secondary substations. The cables and equipment are mainly placed on the edge of the street area or in the strip between the street and the pedestrian and cycle route, for example, but in some places, cables also have to be placed in street areas and structures, which requires that the cables must be protected by placing them in pipes.

The zoning of the areas sets strict requirements for how the electricity network can be built and what kind of structures are allowed: cables must be underground and transformer substations must be kiosk-style secondary substations. Typically, zoning also sets requirements for the permitted locations of aboveground structures and the appearance of structures.

Impacts of operating environment changes on the development zone

In the old network, typical for these areas, electric heating is common. In addition, various heat pump solutions are becoming more common in areas with old heating networks as well as in new areas that are being built. In industrial areas, the use of electricity is expected to increase along with the electrification of industrial processes.

Small-scale production, in particular solar power, will increase significantly and electric cars will become more common, especially in zoned areas surrounding major growth centres. Increasing solar power generation will not pose extensive problems in densely populated areas as it is likely that electricity is consumed near small-scale production, which means that energy distribution distances are short and technical challenges do not emerge in the distribution network. The electricity consumption of properties has been determined on the basis of winter months and peak demand will probably not exceed this.

3. Trunk line connections between densely populated areas

The trunk line connections built between substations ensure the undisturbed electricity distribution to densely populated areas if the substation feeder or the transmission line feeding it is down due to maintenance or a fault. Substations are mainly located in the immediate vicinity of densely populated areas but some of them are also placed outside densely populated areas in order to ensure capacity and develop network management and security of electricity supply. This development zone is located in sparsely populated rural areas and, according to section 51 of the Electricity Market Act, after 2036, the maximum allowed power outage in this development zone is 36 hours. In addition, this development zone plays a significant role in ensuring the 6-hour security of electricity supply in densely populated areas.

Technical characteristics of the development zone and the use of electricity

Elenia's substations are mainly equipped with one main transformer and one main busbar. Consequently, in the event of downtime due to maintenance or a fault, the substation's stand-by supply is arranged from other surrounding substations over solid trunk line connections. The medium-voltage network in the development zone has previously consisted almost completely of overhead lines and it still partly is. The upgrading method used in the development zone is underground cabling.

The capacity under the normal switching situation in the development zone does not differ significantly from other sparsely populated rural areas but power transmitted in stand-by supply situations can be several times higher than under normal circumstances. As a result, the capacity of the network has been determined to be higher in other sparsely populated rural areas.

The energy and power intensity of the development zone varies a great deal depending on population density and the environment. Consumption comes mainly from detached houses and agriculture and, to a small extent, from small industry. As a rule, there are no large concentrations of power consumption; instead, consumption is largely distributed along the network in a ribbon-like manner.

Environmental factors in the development zone

The environment and soil vary significantly in different parts of the development zone. The main principle is that the lines and equipment are placed along roads and on the edges of fields or plots. In determining the location of the network, attention must always be paid to soil conditions that are favourable for installation. Rocky terrain can be circumvented in places, provided that the electrotechnical preconditions are taken into account.

Figure 2 shows Finland's forest coverage percentages, with Elenia's network area highlighted. It can be seen that Elenia's network area is mainly located in very forested areas.

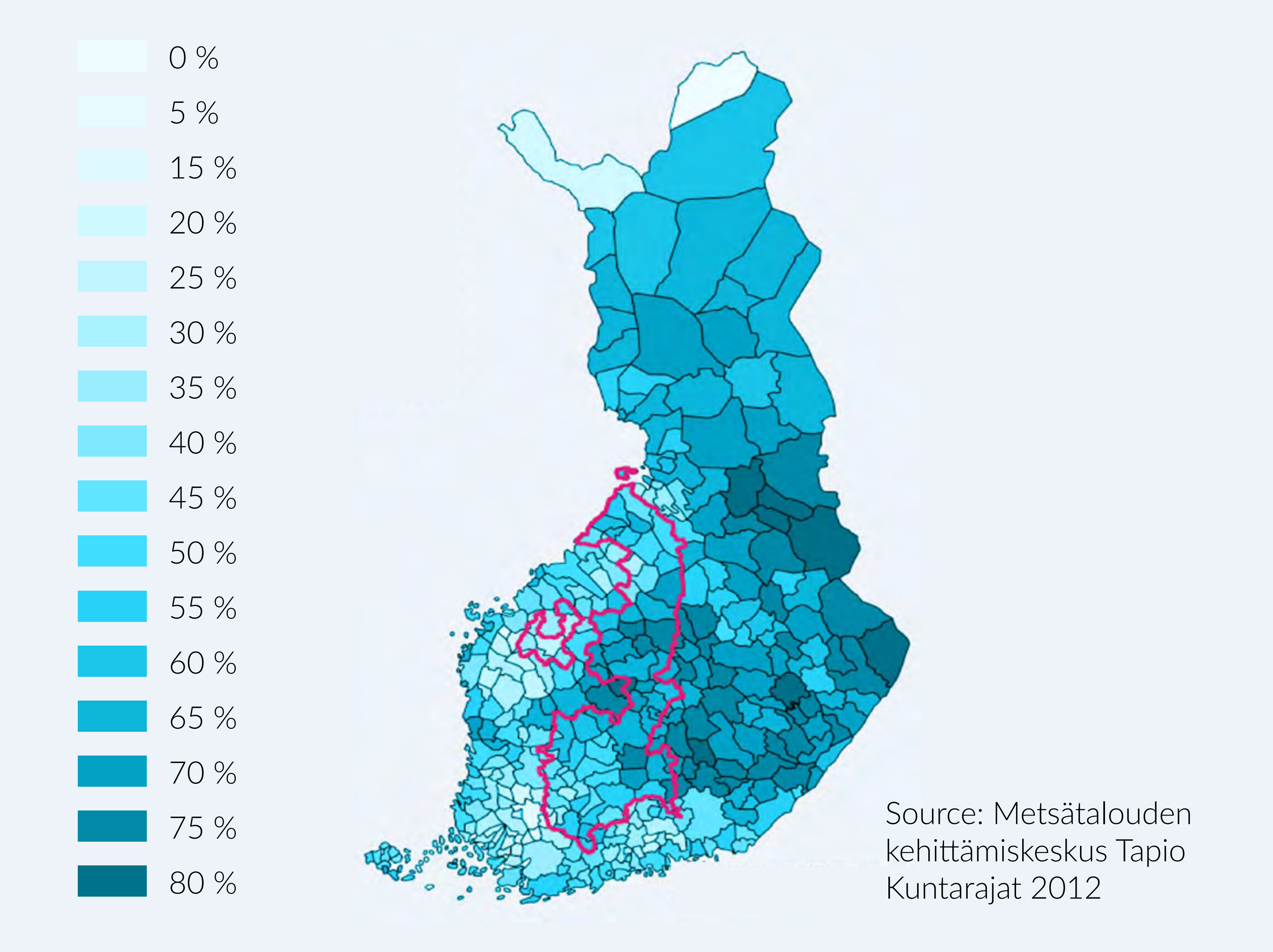


Figure 2: Forest coverage percentages in Elenia's network area

Impacts of operating environment changes on the development zone

Due to the forest coverage in the development zone and climate change described in Annex 1, it is justified to expect that impacts on the overhead line distribution network will be stronger. Taking into account the role of the development zone, it can be noted that the overhead line network does not meet the requirements set regarding security of electricity supply.

In the development zone, the impacts of the electrification of industrial processes, heating and transport can be seen as the expectation of more secure electricity distribution as well as higher power levels, especially in maintenance and fault situations. Electric vehicle charging pools usually require a medium-voltage network and a secondary substation near them. In order to assess the impact of these factors, Elenia has modelled and calculated the impact of e-mobility on the electricity network as part of extensive scenario work.

4. Trunk line connections in sparsely populated rural areas

The key trunk line connections in sparsely populated rural areas normally feed a relatively high level of power and thus serve a significant number of customers.

Technical characteristics of the development zone and the use of electricity

The network of the development zone is extensively looped, so that in case of failure of a single line section, it is possible to restore the electricity distribution to customers outside the fault area by means of operation measures. The network of the development zone differs from trunk line connections between densely populated areas in that it does not function as key substitute links between densely populated areas or substations.

Previously, the network of the development zone was built as an overhead line network. The network has been systematically upgraded since 2013, from substations onwards. The network of the development zone mainly feeds power the spur line (the furthest parts of the network) in

Figure 3: Metering points on the shores and islands of Päijänne

sparsely populated rural areas, the overhead line network to be maintained and the “Flexibility solutions for the security of supply” development zone.

The development zone contains, for example, village concentrations typical of sparsely populated rural areas. The energy and power intensity varies depending on population density and the environment. Typically, there are no large concentrations of power consumption; instead, consumption is distributed along the network in a ribbon-like manner. Electricity consumption comes mainly from detached houses and agriculture and, to a certain extent, small industry.

Environmental factors in the development zone

The environment and other environmental factors are equivalent to those of trunk line connections between densely populated areas.

Impacts of operating environment changes on the development zone

In the development zone, the impacts of the electrification of heating and transport can be seen as increasing power and the electricity users’ expectation of better security of electricity supply. Locally important small-scale production facilities, particularly in agriculture, place increasing demands on the capacity of the network. The investment needs in the distribution network required by the energy transition and the clean transition are described in more detail in Appendix 18 of the background materials.

5. Spur line in sparsely populated rural areas

The development zone consists of the spur line (the furthest parts) of the cable feeder network and the branch networks connected to other development zones.

Technical characteristics of the development zone and the use of electricity

To begin with, the network of the development zone was built as an overhead line network. The age structure of the network is very varied. The network of the development zone has been upgraded on the basis of its age and condition over the years, in connection with projects in other development zones.

The network of the development zone has a looped structure in some places but it is also typical to have only one feed direction without the possibility of backup supply.

There is a wide range of Metering points and varying electricity needs in the development zone. The development zone contains a lot of detached houses and agriculture. In addition, the development zone also contains a significant amount of leisure housing.

Environmental factors in the development zone

The environment and soil of the development zone are partially equivalent to those of trunk line connections between densely populated areas and in sparsely populated rural areas as well as those of the overhead line network to be maintained in sparsely populated rural areas.

In addition to the above, there are lakes and islands in the development zone, which are challenging in terms of fault susceptibility and fault repairs. The second largest lake in Finland, Päijänne, is largely located in the development zone. Figure 3 highlights the Metering points on the shores and islands of Päijänne: more than four hundred Metering points in nearly one hundred separate island locations.

Impacts of operating environment changes on the development zone

The impacts of the operating environment change forecast are different in different parts of the development zone. On one hand, the impacts of the electrification of heating and transport can be seen in the development zone as increasing power and the expectation of better security of electricity supply. Locally important small-scale production facilities, particularly in agriculture, also place increasing demands on the capacity of the network. On the other hand, there are areas in the development zone where the use of electricity remains unchanged or even decreases slightly. Metering points near a body of water typically remain in use and even more of them are built.

6. Overhead line network to be maintained in sparsely populated rural areas

We have identified sections of our network that are justified to be remained as overhead lines until the end of their life cycle from the point of view of the age and condition of the network and the development of electricity use.

Technical characteristics of the development zone and the use of electricity

The characteristics of the development zone are mainly equivalent to those of the spur line in sparsely populated rural areas. The most significant difference is the structure and lifecycle phase of the network of the development zone. The network in the development zone is an overhead line network, with more than 10 years of its technical useful life still remaining. Consequently, the development zone is subject to less upgrading pressure than other development zones and, on the other hand, it is justified to carry out more far-reaching and comprehensive maintenance management actions for the network of the development zone than for an electricity network that is at the end of its lifecycle. The electricity consumption, environmental factors and operating environment changes of the development zone are equivalent to those of the spur line in sparsely populated rural areas.

7. Flexibility solutions for the security of supply

With regard to the electricity network of the development zone, it is justified to consider improving security of electricity supply and capacity management through non-conventional network technologies. In practice, the currently used solution is a battery pack connected to the distribution network.

Technical characteristics of the development zone and the use of electricity

Potential locations for batteries include the branch lines of the medium-voltage network in sparsely populated rural areas, which are located relatively far from a substation and for which a ring connection cannot be built easily because they are located next to a body of water or the border of the distribution district. In this case, the battery pack makes it possible to improve the security of electricity supply in these network sections more quickly than with conventional technologies. The network in the development zone has more than 10 years of its useful life remaining and, consequently, there is no need to upgrade the network due to age and condition and upgrading can be postponed to a later date.

The use of electricity in the development zone is similar or slightly above average than the use of electricity in sparsely populated rural area. The environmental factors and operating environment changes of the development zone are similar to those of the spur line in sparsely populated rural areas and the overhead line network to be maintained in sparsely populated rural areas.

1. Basic information about the development zones

This section presents the basic information about the development zones and the figures describing the network at the end of 2023.

Table 2 shows the average age and the average technical useful life of the network in the development zones. The determination of these figures took into account the ages and estimated technical useful lives of the medium-voltage and low-voltage lines, transformer substations, switchgear and link boxes in the development zones.

According to the quality requirements laid down in the Electricity Market Act, after 2036, there shall not be power outages of over 6 hours in zoned areas or power outages of over 36 hours in sparsely populated rural areas. If the place of electricity use is located on an island without a bridge or another similar fixed connection to the mainland or a regular ferry connection, the network operator can define a different target level based on local conditions. In Elenia's network area, there is one such island: Hailuoto. For Hailuoto, the targeted period of 36 hours starts from the time when the island can be reached by ferry.

Table 4: Average age and average technical useful life of the network in the development zone, years

	Urban areas	Densely populated areas	Trunk line connections between densely populated areas	Trunk line connections in sparsely populated rural areas	Spur line (furthest parts of the network) in sparsely populated rural areas	Overhead line network to be maintained in sparsely populated rural areas	Flexibility solutions for the security of supply
Overhead line network							
Average age	-	34.8	37.5	38.0	41.1	32.5	36.0
Average technical useful life	-	43.5	45.0	44.9	44.8	45.6	45.2
Underground cable network							
Average age	34.3	17.6	8.6	8.6	8.4	16.5	12.1
Average technical useful life	46.6	46.0	46.0	46.0	47.0	47.0	46.1

	Urban areas	Densely populated areas	Trunk line connections between densely populated areas	Trunk line connections in sparsely populated rural areas	Spur line (furthest parts of the network) in sparsely populated rural areas	Overhead line network to be maintained in sparsely populated rural areas	Flexibility solutions for the security of supply	Total
Table 5: Development zone network length at different voltage levels and the extent of the network that meets the operational quality requirements of the electricity distribution network, kilometres								
Medium-voltage network total	26	4,718	6,744	3,321	11,405	2,414	120	28,746
Medium-voltage network that meets the quality requirements	26	4,459	5,030	2,298	7,313	10	27	19,163
Low-voltage network total	118	13,221	9,550	4,635	15,336	3,761	200	46,821
Low-voltage network that meets the quality requirements	117	12,463	6,975	3,152	8,633	939	53	32,332
Table 6: Total number of connections in the development zones								
Zoned area	769	111,364	87	141	180	0	0	112,541
Outside the zoned area	0	13,900	48,457	22,457	73,536	18,676	1,039	178,065
Local conditions	0	81	0	287	165	438	0	971
Table 7: Total number of metering points in the development zones								
Zoned area	10,638	249,427	465	167	182	2	0	260,881
Outside the zoned area	0	15,837	49,717	23,115	72,813	18,785	1,055	181,322
Local conditions	0	139	0	298	215	444	0	1,096
Table 8: Metering points within the scope of the quality requirements of electricity distribution operations, number								
Zoned area	10,498	226,057	334	151	58	0	0	237,098
Outside the zoned area	0	15,641	42,568	18,789	51,255	9,567	132	137,952
Local conditions	0	121	0	100	0	0	0	221
Table 9: Amount of underground cable in the development zones, kilometres								
Medium voltage – underground cable	26	4,445	4,981	2,263	7,286	0	27	19,027
Low voltage – underground cable	117	12,463	6,975	3,152	8,633	939	53	32,332
Table 10: Overhead lines in the forest in different development zones, kilometres								
Medium voltage – overhead line in the forest	0	88	610	385	1,770	776	32	3,661
Low voltage – overhead line in the forest	0	153	655	397	1,990	807	39	4,041
Table 11: Overhead lines by the road at the edge of the forest in different development zones, kilometres								
Medium voltage – overhead line by the road	0	103	536	333	1,140	1,180	38	3,330
Low voltage – overhead line by the road	0	334	1,140	650	2,948	1,563	84	6,719
Table 12: Overhead lines that meet the operational quality requirements of the electricity distribution network, kilometres								
Medium voltage – the overhead line meets the quality requirements	0	14	49	35	27	10	0	135
Low voltage – the overhead line meets the quality requirements	0	0	0	0	0	0	0	0

Development strategy for the network located in the development zone

1. What are the planning criteria considered to meet the operational quality requirements?

In Elenia's network area, there are only substations within the 6-hour and 36-hour quality requirements. The local conditions criteria is not used.

a. 6-hour quality requirement

The 6-hour quality requirement includes transformer substations that supply electricity connections located inside the zoned area, even if the transformer substation supplying the electricity connections is located outside the zoned area. According to Elenia's definition, the 6-hour quality requirement is met by the cable network transformer substations that have a fully underground cabled connection to the transformer substation rail. In the same 20kV output, overhead line sections are allowed if they can be separated from the cable network by manually or remotely disconnecting switches. The 6-hour quality requirement is also considered to be met by the cable network transformer substations that are supplied through the overhead transmission network in normal connection, but the substation has a backup connection via the underground cable network. The low-voltage network can be comprised of overhead line.

b. 36-hour quality requirement

Transformer substations that do not supply connections located in zoned areas are included in the 36-hour quality requirement. According to Elenia's definition, the 36-hour quality requirement is met by transformer substations that have an underground cable connection to the transformer substation's rail and the supply route includes a maximum of 5 km of overhead power line. The overhead line can also be longer if it has been separately found to be weatherproof, that is, genuinely clear of trees. An overhead line marked as weatherproof is considered equivalent to an underground cable in terms of the security of supply. The 36-hour quality requirement is also considered to be met by the transformer substations that are supplied through the overhead transmission network in normal connection, but the substation has a backup connection that is cabled and includes a maximum of 5 km of overhead line. The low-voltage network can be comprised of overhead line.

2. Taking special characteristics into account in network design

This section describes how special characteristics, such as joint construction, connections to the networks of other network operators, Flexibility services and Metering points that are critical for the functioning of society have been taken into account in network design and in the selection of development actions.

Connections to the networks of other network operators

Elenia's distribution network connects to Fingrid's main grid at 108 connection points. Some of the connections are in areas controlled by the transmission system operator at the TSO's substation, to which Elenia connects with its own transmission line of the high-voltage distribution network. These connections typically serve a large number of customers through several of Elenia's substations. In addition, Elenia has so-called power line connections directly to the main grid, in which typically only one of Elenia's substations connects to the main grid. Apart from direct main grid connections, Elenia has 24 connection points to the networks of other high-voltage distribution network operators.

In the medium-voltage network, Elenia has approximately 100 stand-by supply connections with other network companies. The majority of these are medium-voltage network connections. The connections are subject to agreements on distribution capacity, practical arrangements when capacity is needed, and costs. Most of the stand-by supply connections are in the overhead line network, and their capacity typically does not allow feeding power into a very large network section. The connections are mainly used in connection with maintenance downtime. During major power disruptions, the situation is often challenging as because when a local stand-by supply connection is needed, the neighbouring network operator usually has electricity distribution challenges in the same area. The boundary disconnectors for stand-by supply connections are typically controlled locally. Maintaining the capacity and regulatory compliance of stand-by supply connections requires a significant amount of cooperation between companies. For the reasons mentioned above, the network is primarily developed so that sufficient stand-by supply connections are formed within the network operator's own network.

In the high-voltage distribution network, stand-by supply points are continuously maintained and developed, and they form an integral part of the development actions of the high-voltage distribution network. An information exchange system between the network companies is also available in the high-voltage distribution network, enabling real-time, comprehensive monitoring of the connection status in the event that stand-by supply is used.

Promoting joint construction

Elenia has made determined efforts to promote joint construction. Our goal is to combine the infrastructure construction projects of Elenia, cities, towns, municipalities and other operators. We have cooperated systematically and regularly with the municipalities, telecommunications companies and other significant stakeholders in our operating area. The future projects of Elenia's investment programme have been presented to other infrastructure operators in separate meetings well before their launch. The investment programme projects are selected and scheduled in a manner that ensures that Elenia can participate in the projects of the stakeholders in the area and that other infrastructure operators can participate in Elenia's projects.

In 2016–2018, approximately 20 per cent of the line routes constructed by Elenia involved joint construction. In 2019–2020, the share of joint construction increased to as much as 25 per cent. However, the conclusion of the public support programme for broadband projects significantly reduced the volume of joint construction in 2021, when the share of jointly constructed routes fell to 12 per cent. In 2022–2023, we were required to substantially scale back our investment programme and were unable to participate in all potential joint construction projects. As a result, the share of joint construction was below 10 per cent. In 2024–2025, the share of jointly constructed routes remained at around 10 per cent. In the coming years, the number of potential joint construction projects may increase, as numerous fibre optic projects are being planned by various operators, particularly if new support schemes enable fibre deployment in sparsely populated areas. Nevertheless, significant changes in the business environment challenge the future of joint construction from the perspective of distribution system operators' investment capability, and it may not be possible to participate in all potential projects. The share of joint construction is therefore estimated to remain at approximately 10 per cent.

We provide information about our projects in the map service on Elenia's website. In addition to the map service, Elenia has bilateral system solutions with different infrastructure operators to support the smooth exchange of project information. The projects have been entered into the Finnish Transport and Communications Agency's common Verkkotietopiste online information service, as required by the Act on Joint Operation and Joint Construction, ever since the system was introduced. Cabling project areas suitable for joint construction are entered into the Verkkotietopiste service through a dedicated interface. A computer-generated summary map of preliminary excavation routes is entered into the service, in order to make the area details as specific as possible. Projects are automatically entered into the Verkkotietopiste service on a daily basis, provided that they meet certain criteria regarding phases and project type. After their entry in the Verkkotietopiste service, the projects will be searchable by other operators, who can contact Elenia with regard to joint project construction. Projects that are not suitable for joint construction, such as the construction of connections, are not entered into the Verkkotietopiste service, as their turnaround time is typically short and their potential for joint construction is low.

Elenia is a party to an inter-customer agreement on the joint construction of electricity, telecommunications or other infrastructure networks. The agreement defines the customers' common principles applicable to the implementation of construction projects in joint construction projects and on construction sites, as well as the rights, obligations and responsibilities of the different parties to the agreement. The cost allocation criteria are based on the cost allocation recommendation published by Finnish Energy and FiCom or they agreed on a case-by-case basis, depending on the project procurement method, so that joint construction benefits all parties.

Elenia aims at smooth permit practices and the conclusion of land use agreements. We have actively participated in developing, with various stakeholders, practices to facilitate the placement of electrical equipment and cables and to streamline permit processes.

Flexibility services

During 2026, Elenia will develop and implement a solution to connect to the nationwide load control interface provided by the datahub. The objective is to enable Elenia's customers to participate in demand response markets via electricity meters, facilitated by electricity retailers or other electricity market participants. Elenia will actively monitor how electricity retailers and other market actors utilise load control and will engage in discussions with them on how meter-based control could also be leveraged to meet Elenia's own flexibility needs.

Elenia also participates as a member in two projects monitoring the development of network-related flexibility services: the Value for Flexibility (V4F) and FinFlex projects. The Value for Flexibility (V4F) project is implemented jointly by LUT University and Tampere University and focuses, among other things, on developing tools for electricity demand modelling, demand response analysis and electricity network analysis, enabling assessment of network loading, the availability of new forms of flexibility and the functioning of electricity markets. FinFlex is a new congestion management market in which Helen Sähköverkko and Fingrid are piloting smart flexibility solutions for managing grid bottlenecks. In addition to the above, Elenia intends to participate in an expanded FinFlex project no later than 2027 in order to examine, on a market-based basis, the broader availability of flexibility within its network area.

Elenia has identified Flexibility services as one opportunity to improve security of electricity supply. In the context of security of electricity supply, demand response refers to a situation in which, in the event of a maintenance or fault in the electricity network, electricity distribution can be continued with the aid of battery packs serving as electricity storage units and customers' demand response, for example. This has been taken into account as part of Elenia's network development strategy by identifying the currently potential network sections as a separate development zone in the "Flexibility solutions for the security of supply" zone. A more detailed description of the development zone can be found in section 2.

The amendment to the Electricity Market Act that entered into force on 1 January 2026 enables the conclusion of permanent flexible connection agreements in situations where network capacity is insufficient for a traditional fixed connection and where network development driven by the needs of a single customer would be inefficient or would impose unreasonable costs on other customers. At present, no permanent flexible connections are planned. However, in Elenia's view, permanent flexible connections could be feasible, for example, for generation facilities connected to the high voltage network if the primary energy sources of the facilities differ.

For instance, the production peaks of wind and solar power occur at different times[4] of the day and on a monthly basis. Therefore, even if the full production capacity of a single radial power line had already been allocated to wind power, a solar power plant could still be connected to the same line with only minimal curtailment, if any. In such a case, a permanent flexible connection could be offered to the solar power plant, provided that constructing new network capacity specifically for that connection would not serve other Elenia customers, even in the long term.

Flexible connection arrangements are still a relatively new concept, and Elenia is actively engaging in dialogue with potential customers. The objective is to identify cases in which flexible connections represent a mutually beneficial solution for both the customer and the network operator.

Metering points that are critical for the functioning of society

As a result of numerous recent crises, severe storms and changes in electricity consumption patterns, reliable access to electricity has become increasingly critical to safeguarding society's essential functions. Following the issuance of Government Decree 981/2022, Elenia reclassified thousands of critical sites in accordance with the decree. In addition to these officially identified sites, Elenia also identified several thousand other locations as critical, as certain sectors—such as industry—were not included in the categories of critical sites defined under Section 2 of the Government Decree.

Elenia surveys customers' critical Metering points in several ways. A customer criticality assessment is conducted in connection with the acquisition of a new connection, in continuous cooperation with customers that use a lot of electricity and using various security of supply channels. Naturally, information is also obtained through customer notifications.

Information about critical metering points is maintained in operational systems to a limited extent, where they are available when the system or operations managers prioritise the fault repair order. In addition, information about the critical metering points is also available to experts designing the network. Metering points that are critical for the functioning of society are taken into account in targeting network development actions, determining project scope and in the network switching configuration and in the structural protection of components supplying customers on the basis of the criticality of the places in question.

Energy efficiency measures, in particular as an alternative to expanding distribution capacity

In the development of Elenia's electricity network, the primary objective is always to reduce electrical losses, in particular by selecting materials for replacement investments that have lower losses than the components being replaced. Losses in Elenia's network are already at a very low level: network losses account for less than 3% of the total energy transmitted. Elenia participates in the national energy efficiency agreement for the period 2026–2035. Under the agreement, we have committed to reducing our annual electricity distribution losses by 6%, corresponding to a total of 16.4 GWh, by 2035.

In accordance with the energy efficiency first principle, potential energy efficiency measures are assessed as part of network development. However, in the case of a distribution system operator, energy efficiency measures alone cannot in practice achieve results sufficient to increase transmission capacity. Therefore, investments in network expansion and reinforcement are required. In 2018, Elenia commissioned[5] a master's thesis that explored the energy efficiency measures of a distribution system operator. The possibilities to make a difference can be roughly divided into two categories: the company's own electrical losses caused by the distribution network and customers' energy consumption. From the point of view of the network company, the latter can largely be influenced by communication only, but as the 2022 energy crisis showed, customers' energy consumption can be influenced to some extent. However, the change in customers' consumption behaviour achieved in this way cannot be accurately predicted locally, so energy efficiency communications alone cannot guarantee sufficient distribution capacity. On the other hand, network losses can be reduced by replacing components so that the electrical losses of the new components are lower than those of the original ones. Without component replacements, a network company can reduce electrical losses by optimising the network switching state. According to the calculations of the master's thesis, the optimisation of the 110kV network switching situation could, in one case, save 13.5 MWh of energy per year, which roughly corresponds to the annual consumption of one electrically heated detached house. However, the impact of losses in the distribution network on the current-carrying capacity of the network is so marginal in relation to other limiting factors, such as voltage drop or short circuit-current, that the losses do not primarily limit the connection of new loads or production. Thus, energy efficiency measures alone cannot replace conventional network investments.

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[4] *Leikas Elina, Tuuli- ja aurinkovoiman tuotantohuippujen vertailu, 2023.* Available here

[5] *Koskela-Koivisto, Jaakko: Energiatehokkuustoiminnan arvioinnin kehittäminen jakeluverkkoyhtiössä. 2018.* Available here

3. Calculation of network lifecycle costs in development zones

The next section presents the life cycle cost calculations of the network of different development zones with different network technologies. In the calculations, the direct labour and materials costs arising from network design and construction are included in investments at the value of money in the commissioning year. The fact that the network is longer when underground cabling technology is used instead of overhead line solutions is taken into account in investment costs.

Costs arising from operations include the direct costs of regular network inspections, maintenance management metering, maintenance and repair work based on the results of inspections and metering and fault repairs.

Harm caused due to outages (regulatory outage costs) is a way that is used in the regulatory methods of electricity distribution to describe, in monetary terms, the harm caused by outages in electricity distribution on the basis of undistributed electrical energy and interrupted electric power. In the example calculations, harm caused due to outages is based the average power in the example projects and its predicted change as well as the unit prices for interruptions defined by the Energy Authority applied in the regulatory methods of electricity distribution that entered into force on 1 January 2024.

The lifecycle cost calculations do not take into account potential joint construction with other network construction operators as significant changes in the business environment pose challenges to the future of joint construction from the point of view of distribution system operators. In addition, possibilities of joint construction vary considerably from year to year and from region to region, depending on, among other things, the support programmes targeted at other networks.

Elenia is actively following how advanced network solutions, such as electricity storage units and DC technology, are used as part of network development. Elenia participated in the research and equipment development of low-voltage DC distribution in 2008–2019. During this research period, equipment lifecycle costs could not be brought down to a competitive level compared to conventional network technologies.

4. Monitoring of lifecycle costs

The development of Elenia's network is based on a long-term business plan. The business plan is founded on a comprehensive lifecycle cost analysis conducted in 2006–2008 regarding network technologies suitable for Elenia's network area and the network performance achievable with the different technologies. On the basis of the analysis, the underground cabling of the network was chosen as the strategic foundation for the business plan. The business plan defines the cost development goals for the underground cable network construction with regard to construction work, component prices, maintenance and fault management. These have been turned into annual goals, the realisation of which has been monitored and, thus far, achieved. The business plan is updated annually on the basis the previous year's performance and general cost development, such as inflation and changes in the operating environment.

As the useful life of electricity network components is long, it is not possible to change the basic elements of the network strategy annually. Instead, choices have been made to support the chosen foundation strategy, such as increasing automation in the overhead line network to be maintained and developing network management systems. We are actively following how network solutions based on new technology, such as battery energy storage systems and Flexibility services, develop as well as piloting alternative solutions to increase cost knowledge.

Cost comparison of solutions used in the development zones

1. Solutions used in the development zones

Elenia uses underground cabling extensively in the medium-voltage network in all development zones. In addition to the medium-voltage network built with underground cabling, we maintain a significant amount of medium-voltage overhead line network built in previous decades. Structures widely used in the overhead line network include overhead lines and insulated overhead lines. In the medium-voltage network, overhead cables are also used in some places and there are also battery energy storages.

Elenia uses underground cabling extensively in the low-voltage network in all development zones. In addition to the low-voltage network built with underground cabling, we maintain a significant amount of low-voltage overhead line network built in previous decades. The technology that is widely used in the low-voltage network is the AMKA overhead cable. In the low-voltage network, overhead lines are also used in some places and there is one 1-kV electricity distribution site.

Table 13 shows the suitability of different electricity distribution solutions for the conditions in Elenia's development zones, taking into account the level of security of electricity supply according to the quality requirements of the Electricity Market Act, the customers that are critical for the functioning of society, the requirements set by zoning and land use as well as the electricity distribution quality and network capacity requirements set in standards.

Underground cabling is a solution that is suitable for all development zones due to its reliability and relatively minor negative effects on land use. Overhead line solutions are not possible in urban and densely populated areas because of reasons related to land use. Some of the use of electricity in urban and densely populated areas requires a level of security of electricity supply that is higher than the level defined in the quality requirements of the Electricity Market Act and cannot be achieved with overhead line solutions. On the other hand, 1-kV and LVDC electricity distribution solutions are not suitable for urban and densely populated environments due to their insufficient electricity distribution capacity.

Trunk line connections between densely populated areas and in sparsely populated rural areas ensure the security of electricity supply in electricity distribution to a significant share of the customers. These connections are required to have a high level of reliability and thus overhead line solutions, excluding the widened line corridor, do not make it possible to achieve the quality requirements of the Electricity Market Act. The creation of a widened line corridor in the overhead line network requires the clearing of trees from a significant additional area and therefore requires cooperation with landowners. Practice has shown that the creation of a widened line corridor

	Underground cable	Overhead line	Widened line corridor	Insulated overhead line	Overhead cable	1-kV electricity distribution	Electricity storage units	LVDC	Flexibility services
Urban areas	Suitable	Not suitable	Not suitable	Not suitable	Not suitable	Not suitable	Not suitable	Not suitable	Does not comply with the EMA's requirement
Densely populated areas	Suitable	Not suitable	Not suitable	Not suitable	Not suitable	Not suitable	Not suitable	Not suitable	Does not comply with the EMA's requirement
Trunk line connections between densely populated areas	Suitable	Not suitable	Suitable with reservations	Not suitable	Not suitable	Not suitable	Not suitable	Not suitable	Does not comply with the EMA's requirement
Trunk line connections in sparsely populated rural areas	Suitable	Not suitable	Suitable with reservations	Not suitable	Not suitable	Not suitable	Not suitable	Not suitable	Does not comply with the EMA's requirement
Spur line in sparsely populated rural areas	Suitable	Suitable	Suitable	Suitable	Suitable with reservations	Suitable in part	Not suitable	Suitable in part	Does not comply with the EMA's requirement
Overhead line network to be maintained in sparsely populated rural areas	Suitable	Suitable	Suitable	Suitable	Suitable with reservations	Suitable in part	Not suitable	Suitable in part	Does not comply with the EMA's requirement
Flexibility solutions for the security of supply	Suitable	Suitable	Suitable	Suitable	Suitable with reservations	Suitable in part	Suitable	Suitable in part	Does not comply with the EMA's requirement

Table 13: Suitability of network development solutions for different development zones

for the whole network section is very challenging: in practice, there remains narrower sections along the route, with low security of electricity supply, and the corridor route ends up being winding. For these reasons, lifecycle costs become technically and economically unreasonable. 1-kV and LVDC electricity distribution solutions are not suitable for high-capacity trunk line connections due to their insufficient electricity distribution capacity.

In principle, several solutions are suitable for the spur line in sparsely populated rural areas, the overhead line network to be maintained and the "Flexibility solutions for the security of electricity supply" development zone. However, the overhead cable solutions of the medium-voltage network have proved in practice to be challenging in terms of the security of electricity supply and safety. The overhead cable network is susceptible to faults caused by trees during storms and under snow loads, for example. Faults in the overhead cable network are typically more difficult to locate than faults in other overhead line solutions and repairing them is many times slower and more expensive. The use of 1-kV or LVDC electricity distribution solutions is only possible in cases where it is certain that the demand for power in the network section in question will not increase significantly or that it will not be necessary to expand the network substantially at a later stage. Such cases include, for example, islands and, in some cases, lakeside areas.

Flexibility services can take the form of security of supply flexibility or capacity flexibility. For the sake of clarity, in the electricity distribution solutions compared in Appendix 3, flexibility services refer to capacity flexibility. Security of supply flexibility is applied in the Flexibility solutions for the security of supply zone through a joint electricity storage solution implemented by Elenia and an electricity market participant. However, as capacity flexibility addresses short-term overload or peak power situations, it cannot be used to guarantee the level of security of electricity supply required under the Electricity Market Act in storm or snow load conditions.

2. Description of the electricity distribution solutions proposed for the development zones

The following section presents the general descriptions of the electricity distribution solutions with the lowest lifecycle costs, development zone by development zone, and the electricity distribution solutions for which the costs have been compared. Investment costs consist of costs related to network construction. Operational costs consist of maintenance activities carried out on the basis of the findings of the inspections conducted according to the maintenance programme and the repair of faults, if any. In addition, the imputed harm caused due to outages (regulatory outage costs), in accordance with the regulatory methods of electricity network operations, is taken into account in costs. Fault repair costs and the harm caused due to outages have been calculated on the basis of the actual realised costs incurred by Elenia and the fault frequency. In addition, losses caused by the compensation of the reactive power of the cable network are taken into account in operational costs.

Electricity distribution solutions with the lowest lifecycle costs

The "Urban areas" and "Densely populated areas" development zones

In urban and densely populated areas, the medium-voltage and low-voltage networks are built with underground cabling. In connection with renewal, underground cables are installed alongside other existing infrastructure or infrastructure being built. Cable cross-sections are typically 150–240 mm^2 in both the medium-voltage and the low-voltage network. Disconnector devices are used in all transformer substations in such a way that the fault location can be isolated and electricity supply can be restored with ring connections. Transformer substation automation, remote-controlled disconnectors and fault indication devices are installed in suitable locations. In these areas, zoning and land use do not make it possible to use overhead line solutions and it is not possible to meet the quality requirements of the Electricity Market Act.

The typical project scope of the "Urban areas" and "Densely populated areas" development zones is from a few hundred metres to about one kilometre. The investment costs of the projects include the investment costs of equipment needed for the compensation of the earth fault current and reactive power of the cable network.

Trunk line connections between densely populated areas and in sparsely populated rural areas and the spur line in sparsely populated rural areas

In the development zones 3–5, the solution with the lowest lifecycle costs is the underground cabling of the medium-voltage network. Underground cables are primarily installed in the road area or another existing infrastructure zone. Cable cross-sections are typically 95–150 mm² in the trunk lines of both the medium-voltage and the low-voltage network. In the development zone 5, the cable cross-section of 50 mm² is also widely used in the medium-voltage network. The aim is not to build underground cabling for all parts of the network at the same time, but instead, for example, some of the branch lines (development zone 5) leaving the trunk line (development zones 3–4) are renewed when the branch line needs to be replaced due to its condition.

In connection with the cabling of the medium-voltage network, we install remote-controlled disconnectors in kiosk-style secondary substations. We also add fault detection devices to the cable network nodes and to the boundaries of the cable and overhead line network. This makes it possible to isolate fault areas quickly. The low-voltage network is turned into underground cabling at the same time as the medium-voltage network in the same area. Low-voltage overhead line network sections which diverge from the medium-voltage network and are in good condition are maintained in a controlled manner until the end of their lifecycle, after which they are replaced with underground cabling. Typically, approximately 70 per cent of the low-voltage network in the project area is turned into underground cabling at the same time as the medium-voltage network. The remaining 30 per cent is renewed at the end of the network lifecycle, which is calculated to be 20 years after the initial investment. Investment costs include the investment costs of equipment needed for the compensation of the earth fault current and reactive power of the cable network.

Overhead line network to be maintained in sparsely populated rural areas

Our medium-voltage network has sections that can be maintained as overhead lines in a controlled manner until the end of their lifecycle, as far as the development of security of electricity supply and the age and condition of the network are concerned. In the example calculation for the development zone, we compare the realisation of the same underground cabling investment at the beginning of the review period and after the end of the assumed useful life of the overhead line network, 15 years from the beginning of the review period. The remaining value of the network to be dismantled has not been taken into account in the calculation. Underground cabling is carried out according to the equivalent principles as in trunk line connections between densely populated areas, trunk line connections in sparsely populated rural areas and the spur line in sparsely populated rural areas.

Operational costs consist mainly of actions and fault repairs according to the maintenance programme. The line corridors of the overhead line network are photographed and laser-scanned regularly. Line corridors are cleared of trees at regular intervals as well as whenever necessary on the basis of inspection findings. The network has undergone extensive forest management in areas adjacent to it outside the line corridor to improve the security of electricity supply. These forest management activities have been carried out in 2016–2021, and their costs have not been included in the lifecycle cost comparison.

Flexibility solutions for the security of supply

In the development zone 7, the network is maintained as an overhead line network and the security of electricity supply in accordance with the Electricity Market Act is ensured by an electricity storage solution. The electricity storage unit is a battery pack, with an assumed technical life of 15 years. At the end of the lifecycle of the electricity storage solution and the overhead line network to be maintained, the network will be replaced with underground cabling in the same way as in other development zones located in sparsely populated rural areas.

In addition to actions carried out according to the maintenance programme, the line corridors of the overhead line network are photographed and laser-scanned regularly. Line corridors are cleared of trees at regular intervals as well as whenever necessary on the basis of inspection findings. In addition to maintenance and fault management, the operational costs include the service fee paid to the battery pack operator for the use of the battery pack for the needs of the electricity network. In the battery pack solution applied by Elenia, the battery pack serving as an electricity storage unit is placed at the beginning of the medium-voltage network branch, connecting it with connection equipment. The connection equipment features a circuit breaker, which allows the branch to be isolated from the rest of the electricity network and to be fed as an island by means of the battery pack. Similarly, it is possible to isolate a fault in the branch with the circuit breaker without interrupting electricity supply in the rest of the electricity network. The latter case benefits the network outside the development zone, but it has not been taken into account in the example calculations. The impact may be significant, depending on the fault frequency of the branch.

Other compared electricity distribution solutions

The development zones' electricity distribution solutions with the lowest costs have been compared to other technically feasible electricity distribution solutions that meet the quality requirements of the Electricity Market Act, as indicated in Table 11.

The operational costs of all solutions consist of actions and fault repairs according to the maintenance programme. The electricity network is inspected according to the maintenance programme and the necessary maintenance actions are carried out on the basis of the findings. Fault repair costs and the harm caused due to outages have been calculated on the basis of the realised costs incurred by Elenia and the fault rates, to the extent that the solution is used by Elenia.

Overhead line network

The overhead line network used in the comparison is straighter and slightly shorter than an underground cable network. There are slightly fewer transformer substations compared to the underground cable network. The network is partly located in fields and by the road, as indicated in Table 9. Typical medium-voltage network cable types and cross-sections are ACSR 54/9 (Raven), ACSR 85/14 (Pigeon) and AAC 132 in the development zones 3 and 4 and ACSR 34/6 (Sparrow) and ACSR 54/9 (Raven) in the development zones 5–7. The low-voltage network is an AMKA overhead line network with typical cross-sections of 35 mm² and 70 mm².

The line corridor is created and maintained at the normal width, with an area of a width of about 10 metres clear of trees.

Widened line corridor

The widened line corridor network used for the comparison has a technical structure that is equivalent to the structure of an overhead line network. The key difference is the width of the line corridor. The line corridor is created in an extra-wide form: all trees that could bend over or fall on the overhead line are cleared from the vicinity of the line. In this case, the width of the line corridor is typically 30 metres. The low-voltage network is an AMKA overhead line network with typical cross-sections of 35 mm² and 70 mm².

Elenia does not have widened line corridor networks in use so the fault frequency has been estimated based on literature[6].

Insulated overhead line

The medium-voltage insulated overhead line network used for the comparison has a route and transformer substation frequency that are equivalent to those of an overhead line network. Conductors are made of insulated overhead line with a thin layer of insulation on the surface of the actual conductor material, which can withstand the leaning of the fallen tree against the conductor without interrupting electricity distribution. Typical cross-sections are PAS 95 mm² and PAS 150 mm² in the development zones 3–4 and PAS 50 mm² and PAS 95 mm² in the development zones 5–7.

Due to the insulation used in insulated overhead lines, the gap between the conductors can be reduced when compared to an overhead line network, which also means that the width of the line corridor is slightly narrower than in an overhead line network. An area of a width of about 6 metres is cleared of trees.

Overhead cable

The medium-voltage overhead cable used for the comparison has a route and transformer substation frequency that are equivalent to those of an overhead line network. In an overhead cable structure, the conductors are insulated and typically three phase conductors are stranded around a steel support wire. Typical cross-sections in overhead cable structures are 25 mm², 50 mm² and 95 mm². Typically, the maximum cross-section used in an overhead cable structure is 120 mm², which limits the usability of the overhead cable solution in network sections with a high demand for power. Larger cross-sections would require much heavier pole structures.

[6] *Partanen, Jarmo: Sähkönsiirtohinnat ja toimitusvarmuus. 2018.* Available here

Due to the insulation, a tree leaning against the conductor does not usually cause an interruption in electricity distribution but the tree or other foreign objects can damage the insulation material, which can later lead to a fault. Such faults are challenging to locate and fault repairs in the overhead cable network are significantly slower than in the overhead line network. Due to the structural characteristics of the overhead cable network, the network must be inspected after major power disruptions: it may be that the fall of conductors from pole brackets does not result in an interruption in electricity distribution but creates a potential safety risk. This increases disruption-related costs in overhead cable structures. The structure allows for a narrower line area than other overhead line structures. An overhead cable does not require an actual line corridor to be cleared. An area of a width of about 1–2 metres is cleared of trees.

1-kV electricity distribution

1-kV electricity distribution makes it possible to increase the transmission distance of the low-voltage electricity network from approximately one kilometre, typically used in low-voltage 0.4-kV distribution, to up to 8 kilometres. The same structures as in other low-voltage networks can be used the lines, and the network can built as overhead lines or underground cables. In the example calculations, half of the 1-kV electricity distribution solution is assumed to consist of overhead lines and half of underground cables. In contrast to normal medium-voltage and low-voltage electricity distribution, the 1-kV electricity distribution solution requires that the voltage level must be converted from 20-kV medium voltage to 1-kV low voltage and from 1-kV low voltage to 0.4-kV low voltage. In the 1-kV low-voltage network, electrical protection is typically implemented with circuit breakers instead of queue fuse switches normally used in the low-voltage network. The technical and economical power range of 1-kV low voltage is 10–60 kW. The power distribution capacity decreases substantially as the distance increases.

DC system (LVDC)

In the Low Voltage Direct Current system (LVDC), the AC voltage traditionally used in the electrical network is rectified by a rectifier installed at the beginning of the input branch, and the distribution of electricity takes place at DC voltage. An inverter is installed before the customer's connection point, converting the DC voltage into AC voltage again. Various technical variations of LVDC systems have been proposed in the study, but life cycle calculations were done on the assumption that the system is unipolar and comprehensive, that is, the two-wire system and inverters are installed directly at each customer's connection point. The network will be built as an underground cable network.

LVDC provides a cost benefit when low-voltage network materials can be used in construction with certain reservations, but the transmitted power is higher than AC at low voltage and slightly higher than 1 kV at AC voltage. The technical and economical power range of LVDC is 10–75 kW. Elenia has piloted LVDC solutions, but the implementation was not technically and economically viable and the pilots have already been dismantled and replaced with medium-voltage underground cable. The LVDC implementations were pilot projects, so using the realised costs to calculate life cycle costs would not make sense. Literature has been used to assess up-to-date investment costs[7].

Flexibility services

Flexibility services are a broad umbrella term that refers to the procurement of demand response in electricity consumption or production through direct bilateral agreements or from the public market. Demand response can involve either reducing consumption or increasing production, and correspondingly increasing consumption or reducing production. Technically, demand response can be any controlled electricity consumption, ranging from a private customer's hot water boiler to an entire factory process, for example. The transmission system operator Fingrid actively trades various demand responses when balancing the consumption and production of the Finnish electricity system. In contrast to main grid-level Flexibility services, the demand response utilised in the distribution network must be allocated to a specific part of the network, while in the main grid, demand response can be obtained from anywhere in the national grid system. A flexible marketplace suitable for the needs of the distribution system operator is not yet in production use, but Elenia participates in the work of defining the demand response interface led by the transmission system operator Fingrid, and the demand response market is expected to develop significantly in the coming years.

An example of the use of Flexibility services in the development of the network could be that, as the consumption behaviour of private customers increasingly coincides with the lowest-price exchange electricity hours, the distribution substation may become overloaded. Instead of investing in a new larger distribution substation, the network company could purchase demand response regionally during times of heavy load. In practice, it is not yet possible to precisely allocate demand response to a certain part of the network due to the lack of supply and technical solutions. On the other hand, the development of the network must take into account the long, often up to 50-year useful lives of investments. There is great long-term uncertainty associated with local demand response capacity and its availability, because a network company cannot rely on customers' willingness and ability to be flexible in the right place at the right time, also several years from now. However, at best, demand response could buy additional time to make the necessary investments. In addition, flexibility services can be used relatively straightforwardly to implement capacity flexibility, but flexibility services cannot be used to meet the security of supply requirements set out in the Electricity Market Act. On these grounds, Flexibility services as such are not suitable as the main way of developing the network in any development zone.

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[7] *Partanen, Jarmo: Sähkönsiirtohinnat ja toimitusvarmuus. 2018.* Available here

3. Lifecycle cost comparison for the development zones

An example project that serves as a model of a typical project entity has been defined for the development zones, and its main characteristics are summarised in Table 14.

Table 14: Characteristics of the example projects in the development zones

	Urban areas	Densely populated areas	Trunk line connections between densely populated areas	Trunk line connections in sparsely populated rural areas	Spur line in sparsely populated rural areas	Overhead line network to be maintained	Flexibility solutions for the security of supply
Length of the line, medium voltage [km]	0.5 km	0.6 km	15.0 km	17.0 km	5.5 km	6.5 km	10.0 km
Length of the line, low voltage [km]	0.6 km	0.7 km	20.0 km	22.0 km	5.0 km	8.0 km	10.0 km
Mean power [kW]	750 kW	618 kW	292 kW	293 kW	47 kW	146 kW	170 kW
Load change [% per year]	1.5% per year	3.0% per year	0.9% per year	0.9% per year	-0.5% per year	-0.5% per year	-0.5% per year
Forest coverage percentages of the overhead line network	-	-	56%	62%	62%	74%	72%

In addition to the information presented in the table, the lifecycle cost review has been conducted for a 50-year review period with a calculated 4% interest rate. In the lifecycle cost comparison, the technical life of both cable and overhead line network solutions is assumed to be 50 years. Based on our experience, the life expectancy of the overhead line network is likely to be shorter in practice due to the more environmentally friendly impregnating agents currently in use in the poles.

Below you can see the lifecycle cost comparison for all technically feasible electricity distribution solutions in each development zone. The solution with the lowest lifecycle costs is underlined.

	Underground cable
Table 15: Development zone 1 Urban areas: Lifecycle cost comparison of the example project	
Lifecycle cost	<u>**253,359**</u>
Cost of initial investment	245,773
Other investment costs	0
Operational costs	3,860
Harm caused due to outages (regulatory outage costs)	2,475
Table 16: Development zone 2 Densely populated areas: Lifecycle cost comparison of the example project	
Lifecycle cost	<u>**184,363**</u>
Cost of initial investment	173,706
Other investment costs	0
Operational costs	5,808
Harm caused due to outages (regulatory outage costs)	3,349

Not suitable: Overhead line, Widened line corridor, Insulated overhead line, Overhead cable, 1-kV electricity distribution, Electricity storages, LVDC

	Underground cable	Widened line corridor*
Table 17: Development zone 3 Trunk line connections between densely populated areas: Lifecycle cost comparison of the example project with different network technologies		
Lifecycle cost	<u>**1,407,508**</u>	1,700,589
Cost of initial investment	1,160,809	1,144,376
Other investment costs	112,324	-
Operational costs	108,585	191,438
Harm caused due to outages (regulatory outage costs)	25,790	364,775
Table 18: Development zone 4 Trunk line connections in sparsely populated rural areas: Lifecycle cost comparison of the example project with different network technologies		
Lifecycle cost	<u>**1,538,787**</u>	2,003,257
Cost of initial investment	1,256,954	1,328,277
Other investment costs	126,113	-
Operational costs	126,390	232,124
Harm caused due to outages (regulatory outage costs)	29,329	442,856

Not suitable: Overhead line, Insulated overhead line, Overhead cable, 1-kV electricity distribution, Electricity storages, LVDC**,** * Widened line corridor is suitable with reservations

Table 19: Development zone 5 Spur line in sparsely populated rural areas: Lifecycle cost comparison of the example project with different network technologies

	Underground cable	Overhead line	Widened line corridor	Insulated overhead line	Overhead cable**	1-kV electricity distribution***	LVDC***
Lifecycle cost	<u>**360,320**</u>	615,587	459,855	585,348	1,353,442	585,292	717,106
Cost of initial investment	293,544	393,943	363,927	463,557	400,003	362,021	522,898
Other investment costs	32,974	-	-	-	-	-	78,154
Operational costs	32,608	230,800	73,216	98,803	609,741	56,039	10,784
Harm caused due to outages (regulatory outage costs)	1,194	90,844	22,712	22,989	343,698	167,232	105,271

Not suitable: Electricity storages, **Overhead cable corridor is suitable with reservations, ***1-kV electricity distribution and LVDC suitable in part

In our network area, we have identified the areas where the existing network and other characteristics of the area make it possible to use the existing network in a controlled manner until the end of its useful life. Table 18 shows the lifecycle cost calculations for this development zone (Overhead line network to be maintained).

Table 20: Development zone 6 Overhead line network to be maintained in sparsely populated rural areas: Lifecycle cost comparison of the example project with different network technologies

	Underground cable	Overhead line	Widened line corridor	Insulated overhead line	Overhead cable**	1-kV electricity distribution***	LVDC***
Lifecycle cost	541,341	1,150,152	644,691	789,839	2,218,427	1,009,534	1,074,123
Cost of initial investment	443,107	406,288	490,269	609,825	533,560	482,220	572,000
Other investment costs	46,958	-	-	-	-	-	100,126
Operational costs	47,223	385,286	86,290	111,052	653,820	95,875	44,647
Harm caused due to outages (regulatory outage costs)	4,052	358,578	68,132	68,962	1,031,047	431,437	357,349

Not suitable: Electricity storages, **Overhead cable corridor is suitable with reservations, ***1-kV electricity distribution and LVDC suitable in part

Table 21: Development zone 7 flexibility solutions for the security of supply: Lifecycle cost comparison of the example project with different network technologies

	Under-ground cable	Over-head line	Widened line corridor	Insulated overhead line	Overhead cable**	1-kV electricity distribution***	Electricity storages	LVDC***
Elinkaarikustannus	**740,116**	1,623,272	1,004,666	1,228,966	4,121,782	1,942,672	1,032,933	1,780,624
Alkuinvestoinnin kustannus	604,296	592,613	718,585	897,918	783,521	693,148	225,028	868,645
Muut investointikustannukset	63,416	-	-	-	-	-	375,728	168,943
Operatiiviset kustannukset	64,553	440,180	138,457	181,624	1,104,248	149,740	215,829	50,736
KAH-kustannukset	7,851	590,478	147,624	149,424	2,234,013	1,099,784	216,348	692,301

**Overhead cable corridor is suitable with reservations, ***1-kV electricity distribution and LVDC suitable in part

The costs presented do not include standard compensations, compensation for damages or the incentive effects of the regulatory methods of electricity network operations.

Long-term plan

Elenia's investments in meeting the operational quality requirements of the electricity distribution network

In our own monitoring, we consider medium-voltage, transformer substation and low-voltage network investments as one entity and investments in the high-voltage distribution network and substations as another. Therefore, the component division defined for the development plan allows us to provide only indicative figures, with estimates based on annual replacement investments. Actual investment costs are presented at the value of money in the year in which the investment is made. Planned investment costs are presented at the value of money in 2026. Investments do not include replacement investments to be made for connecting new production and consumption into the network in 2026–2035.

	Average, EUR 1,000 per year	Total, EUR 1,000	Comments/Further details
Table 22: High-voltage distribution network, network investments in 2014–2036			
High-voltage distribution network in 2014–2021	1,660	13,279	Actual investments in 2014–2021
High-voltage distribution network in 2022–2028	7,212	50,482	Actual investments in 2022–2025 and investments according to the plan in 2026–2028
High-voltage distribution network in 2029–2036	10,677	85,419	Investments according to the plan in 2029–2036
Table 23: Substations, network investments in 2014–2036			
Substations in 2014–2021	7,436	59,491	Actual investments in 2014–2021
Substations in 2022–2028	6,980	48,863	Actual investments in 2022–2025 and investments according to the plan in 2026–2028
Substations in 2029–2036	6,528	52,223	Investments according to the plan in 2029–2036
Table 24: Medium-voltage network, network investments in 2014–2036			
Medium-voltage network in 2014–2021	50,302	402,419	Actual investments in 2014–2021
Medium-voltage network in 2022–2028	34,486	241,400	Actual investments in 2022–2025 and investments according to the plan in 2026–2028
Medium-voltage network in 2029–2036	48,102	384,815	Investments according to the plan in 2029–2036
Table 25: Secondary substations, network investments in 2014–2036			
Transformer substations in 2014–2021	23,120	184,958	Actual investments in 2014–2021
Transformer substations in 2022–2028	16,724	117,071	Actual investments in 2022–2025 and investments according to the plan in 2026–2028
Transformer substations in 2029–2036	23,282	186,256	Investments according to the plan in 2029–2036
Table 26: Low-voltage network, network investments in 2014–2036			
Low-voltage network in 2014–2021	26,629	213,029	Actual investments in 2014–2021
Low-voltage network in 2022–2028	30,212	211,483	Actual investments in 2022–2025 and investments according to the plan in 2026–2028
Low-voltage network in 2029–2036	47,474	379,791	Investments according to the plan in 2029–2036
Table 27: Entire electricity network, network investments in 2014–2036			
Total in 2014–2021	109,147	873,176	Actual investments in 2014–2021
Total in 2022–2028	95,614	669,299	Actual investments in 2022–2025 and investments according to the plan in 2026–2028
Total in 2029–2036	136,063	1,088,504	Investments according to the plan in 2029–2036

1. Maintenance costs to meet the quality requirements

Actual maintenance costs are based on the budget monitoring of the maintenance work performed. The division of costs among different components is an indicative estimate as not all maintenance work is component-specific. Maintenance costs do not include fault repair costs arising from acute electricity network repair needs. Planned maintenance costs are based on the long-term maintenance plan, which we have prepared on the basis of the operations, not the components. As maintenance is an activity that maintains the security of electricity supply, reported costs include the estimated maintenance programme costs in their entirety. Actual maintenance costs are presented at the value of money in the year in which maintenance was carried out. Planned costs are presented at the value of money in 2026.

	Average, EUR 1,000 per year	Total, EUR 1,000	Comments/Further details
Table 28: High-voltage electricity network, maintenance costs in 2014–2036			
High-voltage electricity network in 2014–2021	1,211	9,690	Actual maintenance costs in 2014–2021
High-voltage electricity network in 2022–2028	1,295	9,066	Actual maintenance costs and maintenance costs according to the plan in 2022–2028
High-voltage electricity network in 2029–2036	1,811	14,487	Maintenance costs according to the plan in 2029–2036
Table 29: Substations, maintenance costs in 2014–2036			
Substations in 2014–2021	1,457	11,658	Actual maintenance costs in 2014–2021
Substations in 2022–2028	1,710	11,967	Actual maintenance costs and maintenance costs according to the plan in 2022–2028
Substations in 2029–2036	2,216	17,731	Maintenance costs according to the plan in 2029–2036
Table 30: Medium-voltage network, maintenance costs in 2014–2036			
Medium-voltage network in 2014–2021	3,487	27,899	Actual maintenance costs in 2014–, including EUR 18,303,000 in Actual costs according to the maintenance programme and EUR 9,596,000 in costs arising from forest management in areas adjacent to the electricity network in 2014–2021
Medium-voltage network in 2022–2028	2,206	15,445	Actual maintenance costs and maintenance costs according to the plan in 2022–2028, including the costs according to the maintenance programme for 2022–2028 and EUR 222,000 in costs arising from forest management in areas adjacent to the electricity network in 2022
Medium-voltage network in 2029–2036	1,590	12,724	Maintenance costs according to the plan in 2029–2036
Table 31: Secondary substations, maintenance costs in 2014–2036			
Transformer substations in 2014–2021	572	4,577	Actual maintenance costs in 2014–2021
Transformer substations in 2022–2028	839	5,875	Actual maintenance costs and maintenance costs according to the plan in 2022–2028
Transformer substations in 2029–2036	897	7,178	Maintenance costs according to the plan in 2029–2036
Table 32: Low-voltage network, maintenance costs in 2014–2036			
Low-voltage network in 2014–2021	1,576	12,610	Actual maintenance costs in 2014–2021
Low-voltage network in 2022–2028	2,079	14,553	Actual maintenance costs and maintenance costs according to the plan in 2022–2028
Low-voltage network in 2029–2036	1,592	12,732	Maintenance costs according to the plan in 2029–2036
Table 33: Entire network, maintenance costs in 2014–2036			
Total in 2014–2021	8,304	66,433	Actual maintenance costs (incl. the maintenance programme and forest management in areas adjacent to the electricity network) in 2014–2021
Total in 2022–2028	8,129	56,906	Actual maintenance costs and maintenance costs according to the plan including the costs of the maintenance programme in 2022–2028 and forest management in areas adjacent to the electricity network in 2022
Total in 2029–2036	8,106	64,852	Maintenance costs according to the plan in 2028–2036

2. Development of the security of electricity supply requirements for Metering points

The reported figures are indicative and will be specified in the annual planning. The values are based on the number of places of electricity use in 2025 and do not take into account the increase in the number of customers.

	Change during the review period, number	Total number of customers in metering points that meet the quality requirements, at the end of the period	% of all	Comments/ Further details
Table 34: Metering points that meet the quality requirements, in zoned areas in 2014–2036				
in 2014–2023	140,262	228,116	88.4 %	Actual 2014–2023
in 2024–2025	8,982	237,098	90.9 %	Actual 2024–2025
in 2026–2028	6,209	243,307	93.3 %	
in 2029–2036	17,574	260,881	100 %	
Table 35: Metering points that meet the quality requirements, outside zoned areas in 2014–2036				
in 2014–2023	92,046	132,547	73.3 %	Actual 2014–2023
in 2024–2025	5,405	137,952	76,1 %	Actual 2024–2025
in 2026–2028	16,107	154,059	85.0 %	
in 2029–2036	27,263	181,322	100 %	
Table 36: Metering points that meet the quality requirements, in areas subject to a quality requirements level based on local conditions, in 2014–2036				
in 2014–2023	231	231	21.3 %	Actual 2014–2023
in 2024–2025	-10	221	20.2 %	Actual 2024–2025
in 2026–2028	0	221	20.2 %	
in 2029–2036	875	1,096	100 %	

3. Development of the quality requirements for the electricity distribution network

The reported figures are indicative and will be specified in the annual planning.

	Low voltage (0.4–1.0 kV)	Medium voltage (1–70 kV)
Table 37: Network that meets the quality requirements, %		
at the end of 2023	69 %	67 %
at the end of 2028	75 %	73 %
at the end of 2036	91 %	93 %

4. Underground cabling rate of the electricity distribution network at different voltage levels, after actions on the dates defined in section 119 of the Electricity Market Act

The reported figures are indicative and will be specified in the annual planning.

Underground cabling rate, %	Low voltage (0.4–1.0 kV)	Medium voltage (1–70 kV)
Table 38: Underground cabling rate after transition periods, %		
at the end of 2023	66.8%	62.2%
at the end of 2028	75.7%	73.3%
at the end of 2036	91.2%	92.6%

5. New production and loads requiring distribution network investments over the next 10 years

In 2026–2030

The development plan describes the actual investment needs arising from asset management, which Elenia seeks to address where possible. In the assessment, efforts have been made to establish an up to date situational picture based on both known customer projects and the scenario modelling described in the strategic forecast. However, investment need does not always equate to investment capacity. Electricity network development should be proactive, as capacity investments require visibility extending 5–6 years ahead. Changes in the regulatory environment and recurring negative developments nevertheless challenge distribution system operators' investment and risk taking capacity in the medium term, meaning that decisions cannot necessarily be committed even 3–4 years in advance. This causes delays in necessary investments, which have now materialised as a worsening capacity shortage, particularly at substation level and in the high voltage network. In addition, in transmission line projects, for example, the average permitting time is approaching two years, further extending delays. The need for investments is therefore greater than ever, but their implementation is challenging in many respects. Elenia has thus prepared to reassess the volumes presented in the development plan should market or regulatory conditions change.

At the beginning of the decade, investments in the high voltage network were driven almost exclusively by wind power. The situation has since changed, and the number of connection inquiries related to generation projects has declined from peak years. These have been replaced by consumption and electricity storage related connection inquiries. As such, connectivity inquiries directed at Elenia's network largely follow national trends. When electricity prices are low, new generation investments are limited, while consumption is being increased. New connection agreements have been concluded in particular for electricity storage facilities and electric boilers for district heating and industrial use. These place growing pressure on consumption side capacity in many areas, and in the coming years, investment needs will focus especially on transformer capacity at substations. Elenia will build new substations and expand existing ones by adding new main transformers in order to meet customer capacity needs. These needs are distributed across the entire network area, with no single area clearly underrepresented. Particular challenges arise in areas where electricity consumption in village settlements outside growth centres has historically been low or moderate, and where the medium voltage network and the substation main transformer were dimensioned accordingly. Now, however, even small and local heat companies are investing in electric boilers, meaning that the power demand of a small municipality may double as a result of a single new connection. The situation is critical in many parts of the network, as available capacity has been fully allocated at numerous substations, making the need for network development evident. The high voltage network is being reinforced to improve the capacity situation at substations, while electricity storage facilities are also increasingly being connected directly to the high voltage network.

Not all new loads or generation are located in or directly connected to the high voltage distribution network or substations, but the capacity requirements of connections to the low and medium voltage networks also accumulate as increased capacity demand at substations and in the high voltage network. Fully electric vehicles, plug in hybrids and home batteries are also expected to become more widespread, and the charging power they require challenges the low voltage network. Charging of electric vehicles, home batteries and other high power consumption will in the future increasingly be allocated to the lowest priced spot electricity hours, requiring increased capacity in low voltage lines and distribution transformers. Electricity consumption for residential heating will increase as other fuels are replaced by heat pumps.

In 2030–2036

Although generation investments have temporarily slowed, wind power projects in particular continue to be actively developed. Elenia therefore expects a significant volume of new generation to be connected to the high voltage distribution network during the latter half of the review period. In the future, the increasing size of wind farms will make their connection to the 110 kV voltage level challenging from a transmission capacity perspective. One solution to this is the development of a 400 kV high voltage distribution network. Elenia views the development of a 400 kV network primarily as an opportunity and is actively engaging in discussions with potential customers so that both consumption and generation related projects can be connected at the 400 kV level. This would allow the electricity network infrastructure to be utilised as efficiently as possible while minimising adverse impacts on land use and local communities. On the consumption side, new high voltage network connections are expected from data centres and the production of e fuels. These are assumed to be located in areas with strong and secured connections to the transmission system, as data centres in particular require very high security of supply and their power demand may amount to several hundreds of megawatts.

At substation level, investment needs are expected to continue. Should temporary flexible connection agreements be concluded in the coming years, the network development required by these agreements will be scheduled for the turn of the decade and thereafter. Towards the end of the decade, electricity consumption in industry is expected to be significant in expanding industrial areas, and new carbon free production is expected to encourage further investments in energy intensive industry. Heavy electric transport is also expected to become more common by the end of the decade, as the first megawatt scale charging solutions are already available on the market. Heavy transport is critical from a security of supply perspective, and charging locations are expected to concentrate around service station networks. As a result, a significant demand for heavy duty charging power will be concentrated in geographically limited areas, and this capacity must be secured so that a single electricity distribution disturbance does not paralyse all traffic. Highways 4 and 9 cross large parts of Elenia's network area, making it reasonable to assume that heavy duty vehicle charging will require investments by Elenia both in the high voltage distribution network and in the medium voltage network.

6. Significant investments due to new production and loads over the next 10 years (in euros)

Table 39 provides an estimate of the distribution network investments to be made in order to make it possible to connect new production and new loads.

Table 39: Significant distribution network investments to be made in order to connect new production and new loads in 2026–2035

	2026–2030 [EUR 1,000]	2031–2035 [EUR 1,000]
High-voltage network and substations	158,609	205,712
Increase of the distribution network capacity in connection with upgrading	108,509	187,025
Distribution network expansion investments	31,762	31,435
Smart meters	8,438	8,607
Total	**307,318**	**432,779**

Investments in the high-voltage network and substations will be made, above all, to enable the connection of wind power, solar power, electric boilers and electricity storages. It is expected that the charging infrastructure required by heavy duty electric vehicles will also require investments in the high-voltage distribution network towards the end of the decade. In addition, investments in the high-voltage distribution network will be made mainly in the vicinity of densely populated areas, in order to increase distribution capacity and improve the security of electricity supply. Several substations will be expanded to increase capacity.

In connection with upgrades to the medium-voltage and low-voltage network, network capacity will be increased to make it possible to connect new production and new loads. Stronger lines will be built and an increase in the capacity of distribution transformers will be made possible by structural choices in transformer substations and by increasing the number of transformer substations. In addition, network capacity will be increased based on the needs of customers so that more production or consumption can be connected to the network. The distribution network will be expanded by connecting new residential and industrial areas to it. Investments to be made for individual consumer connections are not included in the figures.

The new smart meters enable more accurate metering and thus more accurate determination of network capacity as the use of electricity changes due to the energy transition. In addition, they offer remote control options for the needs of the developing electricity market. Elenia completed the replacement project for next generation smart meters in 2025, meaning that the meter investment figures now reflect meters installed for new customers.

7. Illustration of connecting new production and new loads in the network area

In Elenia's network area, wind power generation is concentrated in North Ostrobothnia, where the increase in number of new low voltage network connections is otherwise smaller due to the decrease in the region's population, among other reasons. The operational and under-construction wind power projects connected to Elenia's network can be seen **in the map service** on Elenia's website.

The focus of the electrification of transport will be on the main roads. Significant electric vehicle charging stations are expected to be concentrated along roads 4 and 9, with implications for the development of the distribution network in the area. Figure 4 illustrates Elenia's network area and the main roads through it.

With the electrification of industry and the development of new industrial areas, the need for power will increase, especially in the Hämeenlinna and Pirkanmaa regions. The electrification of industry is expected to be concentrated near growth centres and in existing industrial areas.

The free capacity of Elenia's distribution network has been illustrated in the **Elenia Avoin** service in connection with the consultation of the development plan. The service visualises the available capacity of the low-voltage network at the secondary substation level, the capacity of the medium-voltage network at the feeder level and the high-voltage network capacity at the line segment level on a map. The aim of the service is to illustrate the general situation of electricity network capacity, so that the exact line routes of the medium-voltage network are not published.

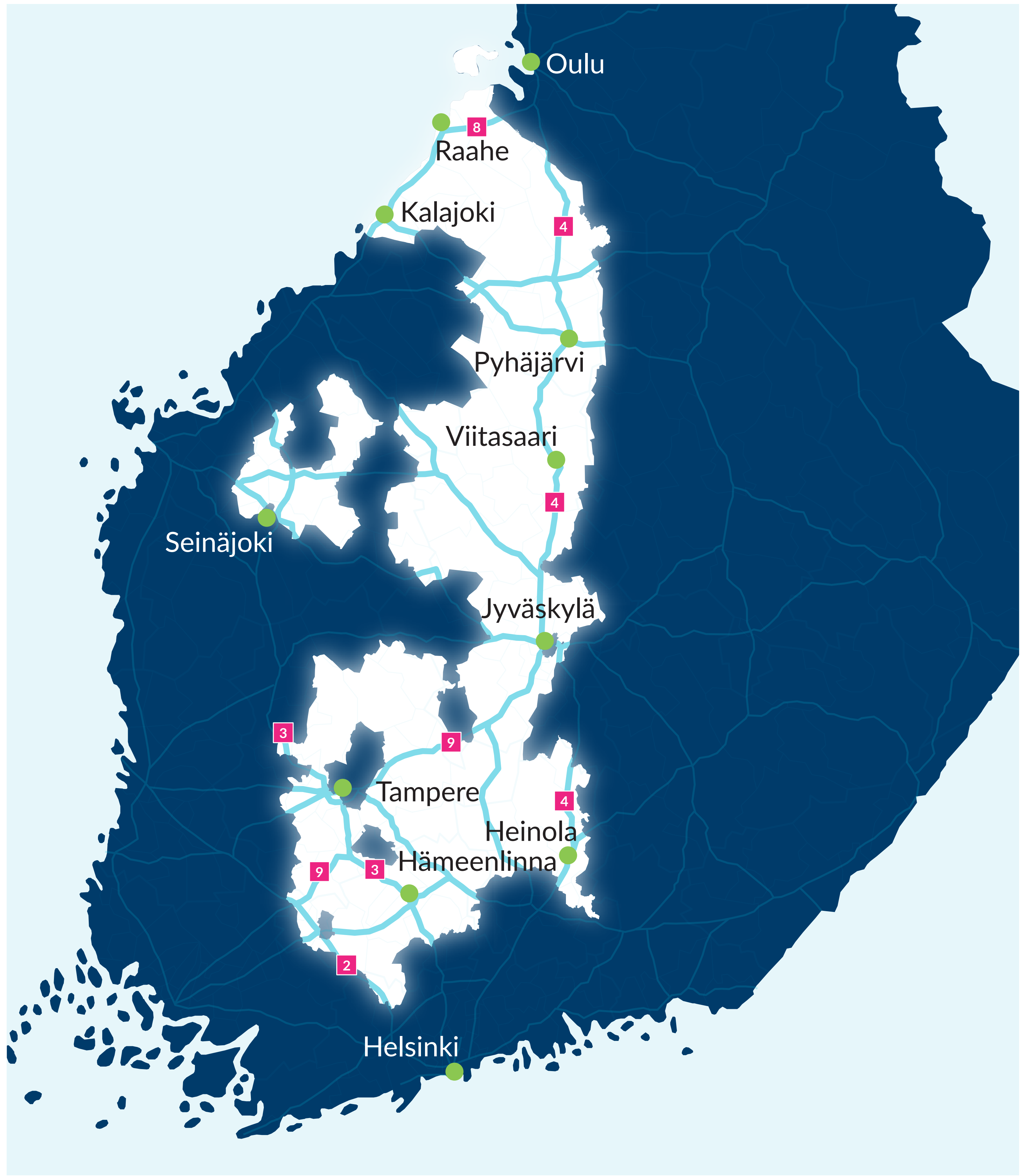
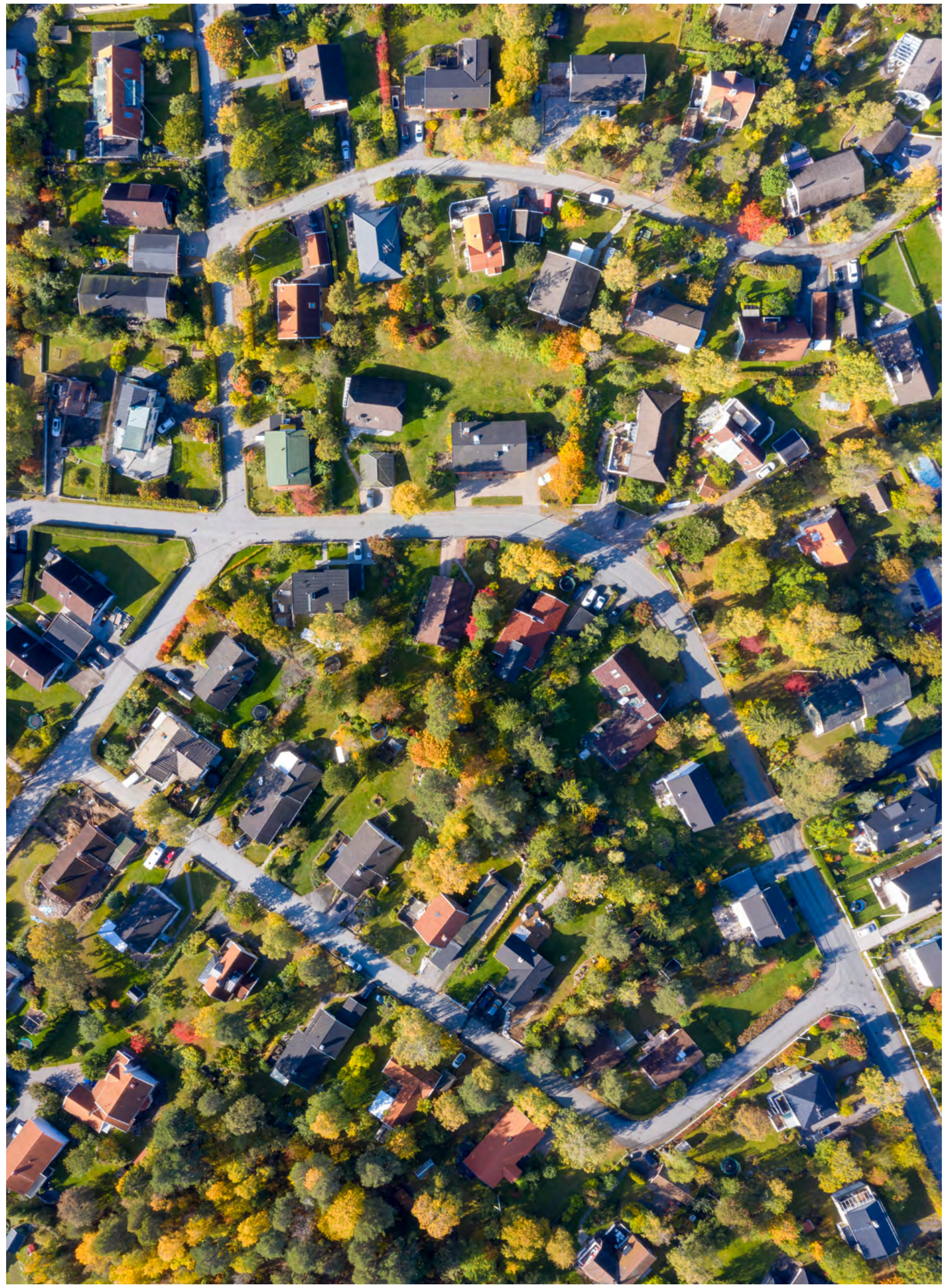


Figure 4: Elenia's network area and main roads.

Electricity distribution network development actions in the current and next year



1. Elenia's investments in meeting the quality requirements (current and next year)

Investment amounts under the given component division are indicative on an annual basis, with estimates based on annual replacement investments. In our own monitoring, we consider medium-voltage, transformer substation and low-voltage network investments as one entity and investments in the high-voltage distribution network and substations as another. Annual investment costs are presented at the value of money in 2026. Investments do not include replacement investments to be made for connecting new production into the network.

Table 40: Electricity network replacement investments in 2026 and 2027

	2026, EUR 1,000	2027, EUR 1,000	Total, EUR 1,000
High-voltage electricity network	2,186	7,483	9,669
Substations	4,526	7,926	12,452
Medium-voltage network	31,589	41,626	73,215
Secondary substations	15,355	20,104	35,459
Low-voltage network	31,652	40,457	72,110

Planned maintenance costs are based on the long-term maintenance plan, which has been prepared on the basis of the operations, not the components. As maintenance is an activity that maintains the security of electricity supply, reported costs include the estimated maintenance programme costs in their entirety. Costs do not include fault repair costs. All costs are presented at the value of money in 2026.

Table 41: Electricity network maintenance costs in 2026 and 2027

	2026, EUR 1,000	2027, EUR 1,000	Total, EUR 1,000
High-voltage electricity network	1 506	1 649	3 155
Substations	1 844	1 852	3 696
Medium-voltage network	2 527	2 489	5 015
Secondary substations	874	909	1 783
Low-voltage network	2 123	1 983	4 107

2. Metering points in Elenia's network that will be within the scope of the quality requirements after the actions of the current and next year

	2026	2027	Comments/Further details
Table 42: Metering points within the scope of the quality requirements in zoned areas in 2026–2027			
Zoned area Meets the operational quality requirements of the electricity distribution network (number)	238,195	241,344	The figures are annual estimates based on planned projects and annual investments.
Table 43: Metering points within the scope of the quality requirements outside zoned areas in 2026–2027			
Areas other than zoned areas Meets the operational quality requirements of the electricity distribution network (number)	142,236	147,462	The figures are annual estimates based on planned projects and annual investments.
Table 44: Metering points within the scope of the quality requirements in areas subject to a quality requirements level based on local conditions, in 2026–2027			
Areas subject to a quality requirements level based on local conditions Meets the operational quality requirements of the electricity distribution network (number)	221	221	The figures are annual estimates based on planned projects and annual investments.

3. Actions in the current and next year by development zone

Information systems, automation and smart metering devices

1. The operation support system and the operation and control information system will be revised so that in the end, the operation supervisor and operation planner will have a tool that provides an even better and more real-time overview of the electricity network through metering, analytics, advanced calculation and automatic network monitoring. The work will require a significant amount of work and, in particular, development work with system partners, and it will take several years.

2. We will continue the cyber security work of automation and information system environments.

3. We will continue to develop the features and use of the next-generation smart meters in different information systems. The new metering system enables the proactive management of changing production and load situations in the electricity network in a more comprehensive way. The aim is to enable Elenia's customers to participate in the demand response market in the future.

4. We will continue to increase network automation and fault indication as part of conventional network investments.

High-voltage distribution network

1. The 110-kilovolt high-voltage distribution network will mainly be built as an overhead line network, but some sections will be built with underground cabling for land-use reasons. The security of electricity supply of the high-voltage distribution network will be ensured by maintaining the conductors and line corridors of the overhead line network so that they can withstand falling or bending trees. Substation investments are also include earth fault current and reactive power compensation equipment and upgrading and replacing switchgear, control gear and secondary equipment. Substation switchgear and control gear are typically used until the end of their lifecycle but at the same time, investments significantly improve the reliability of substations. The maintenance programme actions will also be carried out in the development zones.

Development zones 1–2

1. Electricity networks that are located in urban and densely populated areas and supply electricity to these areas will be upgraded as necessary, mainly in cooperation with municipalities as land use develops. In addition, joint construction will be carried out with other operators that build and maintain civil engineering networks. The maintenance programme actions will also be carried out in the development zones.

Development zones 3–5

1. The medium-voltage network will be upgraded with underground cabling so that connections with sufficient capacity and reliable security of electricity supply will be established between densely populated areas and between substations. The trunk lines of the medium-voltage network will be upgraded, from substations onwards. Remote-controlled disconnector devices and fault indication devices will be installed at the boundary between the overhead line branches and the development zone 6. With them, faults can be detected and the branches can be isolated from the feeding trunk line with the least possible amount of switchings.. The maintenance programme actions will also be carried out in the medium-voltage network.

2. The low-voltage network will be built with underground cabling in the same area as the medium-voltage network where this is technically and financially justified in connection with the installation of medium-voltage cabling. The maintenance programme actions will also be carried out in the low-voltage network.

3. In addition, the medium-voltage and low-voltage networks in the development zones will be upgraded even in a fast schedule, as far as possible, in cooperation with other operators that build and maintain civil engineering networks. This makes it possible to upgrade the network cost-efficiently, minimising the inconvenience caused to users in the areas in question.

Development zone 6

1. Maintenance programme actions will be carried out for the medium-voltage network in a way that ensures the network's safety and security of electricity supply. In the medium-voltage network, individual poles and cross-arms will be replaced on the basis of inspection findings. Enhanced maintenance actions, such as tree-clearance by helicopter, that have impacts over a period of 5–10 years will also be concentrated in the development zone.

2. The maintenance programme actions will be carried out in the low-voltage network.

Development zone 7

1. The operation of existing and new battery packs to be installed will monitored and analysed with a view to possible further development and new locations.

2. The maintenance programme actions will be carried out in the network of the development zone.

Table 45: Share of network to be upgraded by development zone, km

	Urban areas	Densely populated areas	Trunk line connections between densely populated areas	Trunk line connections in sparsely populated rural areas	Spur line in sparsely populated rural areas	Overhead line network to be maintained	Flexibility solutions for the security of supply	Total
Medium-voltage network	0	76.6	301.3	200.5	602.2	80.4	0	1,261.0
Low-voltage network	0	58.6	262.0	162.1	468.3	63.5	0	1,014.5

4. Distribution network meeting the quality requirements after the actions of the current and next year

Table 46: Electricity network that meets the quality requirements, in 2026 - 2027

2026					
Voltage level	**0.4 kV**	**20 kV**	**45 kV**	**110 kV**	**Total**
Network that meets the quality requirements, km	33,275	19,892	304	1,550	55,021
2027					
Voltage level	**0.4 kV**	**20 kV**	**45 kV**	**110 kV**	**Total**
Network that meets the quality requirements, km	34,473	20,817	302	1,577	57,169

5. Underground cabling rate of the electricity distribution network at different voltage levels after the actions of the current and next year

Table 47: Underground cabling rate of the electricity network at the end of 2026 and 2027

2026					
Voltage level	**0.4 kV**	**20 kV**	**45 kV**	**110 kV**	**Total**
Underground cabling rate, %	70.6 %	68.1 %	25.7 %	0.9 %	68.1 %
2027					
Voltage level	**0.4 kV**	**20 kV**	**45 kV**	**110 kV**	**Total**
Underground cabling rate, %	72.5 %	70.5 %	28.5 %	0.9 %	70.1 %

6. Share of joint construction of planned investments

Table 48 provides an estimate of the route length that involves joint construction and its share of the total route length to be built.

Table 48: Share of joint construction of the route length to be built

	2026	2027	Comments/Further details
Share of joint construction [km]	75	118	193
Share of joint construction [%]	10.6 %	8 %	9.3 %

7. Publication of investments in the Verkkotietopiste service

Elenia's major cabling project areas are automatically entered into the Verkkotietopiste service through a dedicated interface. Projects are entered into the Verkkotietopiste service on a daily basis once their implementation decision is made. Typically, projects for the following year are entered into the Verkkotietopiste service by the end of June at the latest. However, projects that are less suitable for joint construction, such as the construction of connections, are not entered into the Verkkotietopiste service, as their turnaround time is typically short and their potential for joint construction is low.

8. Distribution network investments to be made in order to connect new production and loads in the current and next year a

Table 49 shows the significant distribution network investments to be made in the current and next year in order to connect new production and new loads.

Table 49: Significant investments to be made in the current and next year in order to connect new production and new loads (6a)

	2026 EUR 1,000	2027 EUR 1,000	Comments/ Further details
High-voltage network and substations	28,023	27,136	
Increase of the distribution network capacity in connection with upgrading	7,817	8,490	
Distribution network expansion investments	6,246	6,439	
Smart meters	1,173	1,824	
Total	**43,259**	**43,889**	**87,148**

During 2026 and 2027, five transmission line projects will be implemented to enable the connection of new electricity generation and consumption. In parallel, investments in the high voltage distribution network will be carried out mainly in the vicinity of urban areas in order to increase transmission capacity and improve the security of electricity supply. Development of the high voltage network is challenged by prolonged permitting processes, and in anticipation of this, planning projects for future construction works will be initiated during this and the coming year.

In 2026 and 2027, five new 110/20 kV substations will be constructed, and several existing substations will be expanded to increase capacity. The transmission system operator Fingrid requires the implementation of local disconnection protection if a generation facility or an electricity storage unit exceeding 1 MVA is connected to the medium voltage network. As demand for generation and electricity storage connections has increased significantly, 110 kV voltage transformers will be added at several substations and protection arrangements will be modified accordingly. At prioritised security of supply sites, shrapnel protection for main transformers and other measures to strengthen the impact resistance of substations will be implemented.

In connection with upgrades to the medium voltage and low voltage networks, network capacity will be increased to enable the connection of new generation and new loads. Lines will be constructed with higher capacity than before, and increases in distribution transformer capacity will be enabled through structural design choices at substations and by increasing the number of substations. In addition, network capacity will be expanded based on customer needs in order to connect growing generation or consumption. The distribution network will also be expanded by connecting new residential and industrial areas to the network. Investments carried out to serve individual consumer connections are not included in the figures.

9. Use of flexibility services in the current and next yeara

During 2026, Elenia will develop and implement a solution to connect to the nationwide load control interface provided by the datahub. The objective is to enable Elenia's customers to participate in demand response markets via electricity meters, facilitated by electricity retailers or other electricity market participants. Elenia will actively monitor how electricity retailers and other market actors utilise load control and will engage in discussions with them on how meter-based control could be leveraged for Elenia's own flexibility needs.

Elenia also participates as a member in two projects monitoring the development of grid flexibility services: the Value for Flexibility (V4F) and FinFlex projects. The Value for Flexibility (V4F) project is jointly implemented by LUT University and Tampere University and focuses, among other things, on developing tools for electricity demand modelling, demand response analysis and electricity network analysis, enabling assessment of network loading, the availability of new types of flexibility and the functioning of electricity markets. FinFlex is a new congestion management market in which Helen Sähköverkko and Fingrid are piloting smart flexibility solutions to manage electricity network bottlenecks. In addition to the above, Elenia will participate in an expanded FinFlex project no later than 2027 in order to assess, on a market based basis, the broader availability of flexibility within its network area.

In 2021, Elenia launched an innovation partnership procurement process for a market based battery solution suitable for the distribution network. Under normal conditions, the battery system operates in electricity markets, but in the event of a disturbance in the supplying network, it supports the distribution network by feeding the branch downstream of the battery as an isolated island. Fortum Power and Heat Oy and Merus Power Dynamics Oy were selected as partners in the procurement process. The innovation partnership included joint development, and the first developed battery solution was completed in 2025. The performance of the new equipment will be closely monitored in the coming years, and decisions on wider deployment will be made based on the results.

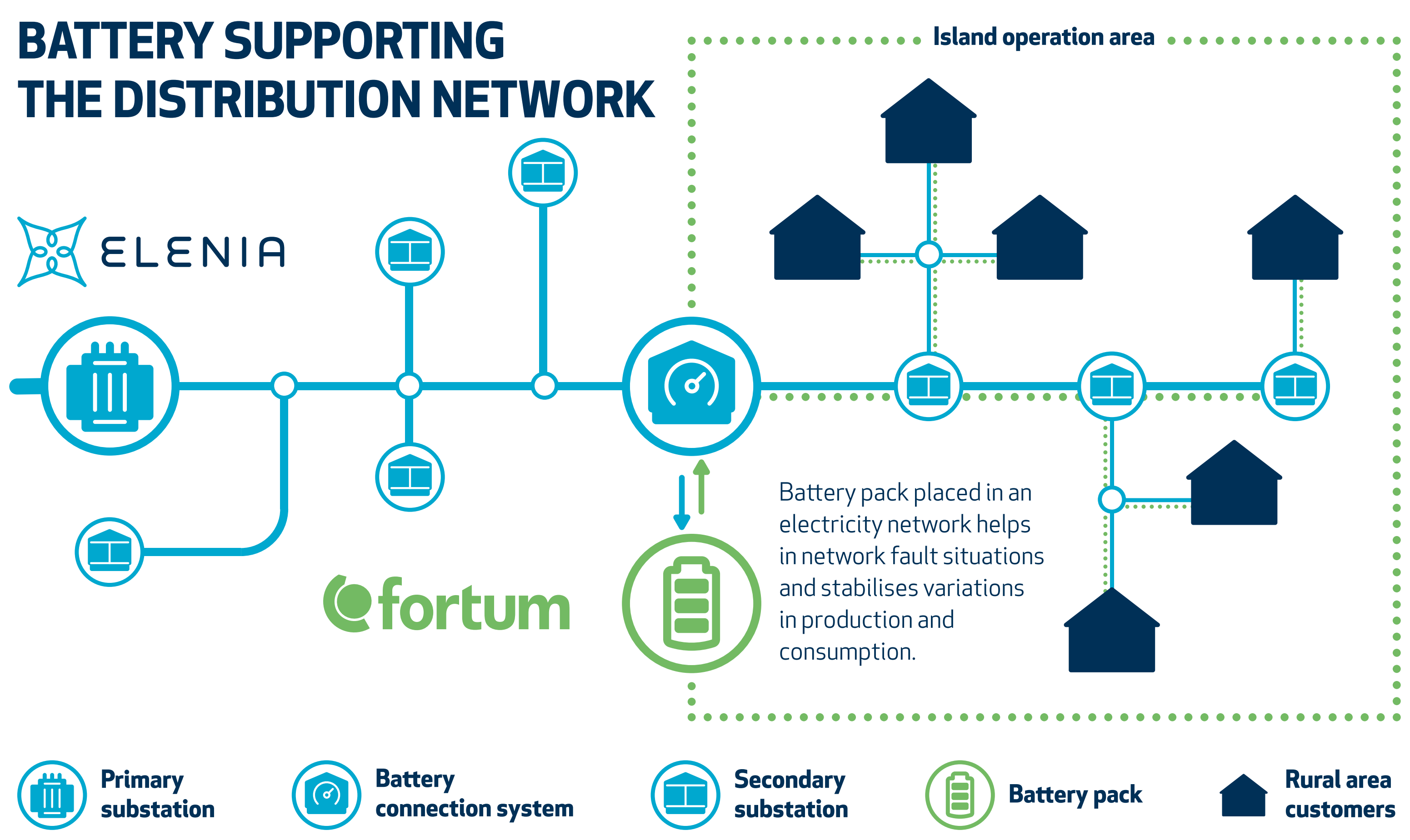


Figure 5: Principles of Elenia's battery concept

We have identified potential locations in our network where improving the security of electricity supply will be cost-efficient in the near future with the aid of electricity storage units. These areas form the "Flexibility services for the security of supply" development zone, which is described in more detail in section 3. The electricity storage units will be battery packs connected to the medium-voltage level. The first battery equipment pilot was commissioned in 2020. The development of the new system has had its own challenges, and the production use of the new battery equipment implemented as an innovation partnership procurement has been delayed from the original plan, but the first two systems have been commissioned during 2025. The estimated costs and benefits during their lifecycle are presented in Table 49.

Taulukko 50: Arvioidut kustannukset ja hyödyt joustopalveluiden hyödyntämisestä

	2026 EUR 1,000	2027 EUR 1,000	Total EUR 1,000	Comments/ Further details
Deployment costs	258,9	0	258,9	2 locations in 2026
Operational costs	10,8	10,8	21,6	
Cost benefits	-	-	680.0	Savings in regulatory outage costs estimated over the lifecycle

The lifecycle of a battery pack is estimated to be 15 years. Customers both inside and outside the battery storage island benefit from the shortening of the interruption time in the network section secured by the battery pack and from a separate protection zone achieved with the protection and circuit breaker equipment connected to the battery pack. Faults in the section beyond the battery pack can be isolated without any interruption perceivable in the rest of the network. For Elenia, the cost benefits consist of savings in regulatory outage costs (harm caused due to outages), among other things. In addition, the converter equipment of the battery pack can be used for compensating reactive power. This cost benefit is not included in the estimate.

Electricity distribution network development actions in the preceding two years

1. Investments in meeting the quality requirements (the preceding two years)

The table shows the electricity network replacement investments in 2024 and 2025. Investments are reported as book values at the value of money in the year in which they are made.

Table 51: Electricity network replacement investments by voltage level in 2024 and 2025

	2024, EUR 1,000	2025, EUR 1,000	Total	Comments/ Further details
High-voltage electricity network	14,906	9,877	24,783	
Substations	7,810	1,138	8,948	
Medium-voltage network	19,109	25,752	44,861	*
Secondary substations	12,444	15,774	28,218	
Low-voltage network	17,959	23,906	41,865	

*The division between the medium-voltage network, secondary substations and the low-voltage network is indicative

2. Maintenance costs to meet the quality requirements (the preceding two years)

The table shows the actual electricity network maintenance costs in 2024 and 2025. Costs are reported as book values at the value of money in the year in which they were incurred.

Table 52: Actual electricity network maintenance costs by voltage level in 2024 and 2025

	2024, EUR 1,000	2025, EUR 1,000	Total	Comments/ Further details
High-voltage electricity network	1,398	884	2,282	
Substations	1,583	1,798	3,381	
Medium-voltage network	1,914	2,068	3,982	
Secondary substations	,710	692	1,403	
Low-voltage network	2,169	2,763	4,932	

3. Metering points within the scope of the quality requirements after the preceding actions

Information about Actual figures are based on information reported from the network information system.

Table 53: Metering points within the scope of the quality requirements in zoned areas in 2024 and 2025

Zoned area	2024	2025
Metering points that meet the operational quality requirements of the electricity distribution network (number)	233,051	237,098

Table 54: Metering points within the scope of the quality requirements outside zoned areas in 2024 and 2025

Outside zoned areas	2024	2025
Metering points that meet the operational quality requirements of the electricity distribution network (number)	135,230	137,952

Table 55: Metering points within the scope of the quality requirements in areas subject to a quality requirements level based on local conditions, in 2024 and 2025

Areas subject to a quality requirements level based on local conditions	2024	2025
Metering points that meet the operational quality requirements of the electricity distribution network (number)	225	221

4. Actions in the preceding two years by development zone

Information systems, automation and smart metering devices

1. Elenia has launched a development project together with its system partner to replace the current Distribution Management System (DMS) with an Advanced Distribution Management System (ADMS). The project is multi year in nature, and the deployment of the new system is estimated to take place around the turn of 2028–2029. The new system will provide enhanced functionalities for managing an evolving and increasingly complex electricity network. For example, real time power flow calculations and switching state optimisation will enable more efficient utilisation of flexibility services and more effective use of the network.
2. We continued to increase network automation and fault indication as part of conventional network investments.
3. Projects that enhance cyber security have been implemented in automation and system environments.
4. The operation of the automatic fault location, disconnection and supply restoration system was developed to better correspond to the current network topology, as well as to make better use of the information available from the fault indicators.
5. The project to install next-generation smart meters started in 2021 and large-scale replacements finished in 2025.

High-voltage distribution network

1. The 110-kilovolt high-voltage distribution network has mainly been built as an overhead line network, but some sections has been built with underground cabling for land-use reasons. The security of electricity supply of the high-voltage distribution network has been ensured by maintaining the conductors and line corridors of the overhead line network so that they can withstand falling or bending trees. Substation investments were made by installing local disconnection protection, earth fault current and reactive power compensation equipment and by upgrading and replacing switchgear, control gear and secondary equipment. Substation switchgear and control gear are typically used until the end of their lifecycle but at the same time, investments significantly improve the reliability of substations. The maintenance programme actions have also been carried out in the development zones.

Development zones 1–2

1. Urban and densely populated areas and the medium-voltage network supplying electricity to them are extensively built with underground cabling. Underground cabling has been started from substations and targeted at areas where it has been possible to replace the entire supply route with underground cables. The maintenance programme actions have also been carried out in the areas.
2. The low-voltage network has been built with underground cabling in the same area as the medium-voltage network where this has been technically and financially justified in connection with the installation of medium-voltage cabling. The maintenance programme actions have also been carried out in the area.
3. In addition, the medium-voltage and low-voltage networks in urban and densely populated areas have been built even in a fast schedule, as far as possible, in cooperation with other operators that build and maintain civil engineering networks. In difficult areas, this has made it possible, to some extent, to upgrade the network cost-efficiently, minimising the inconvenience caused to users in the areas in question.

Development zones 3–5

1. The medium-voltage network has been upgraded with underground cabling so that connections with sufficient capacity and reliable security of electricity supply have been established between densely populated areas and between substations. The trunk lines of the medium-voltage network have been built with underground cabling, from substations onwards. Remote-controlled disconnector devices and fault indication devices have been added at the beginning of overhead line branches. With them, faults can be detected and the branches can be isolated from the feeding trunk line with the least possible testing connections. The maintenance programme actions have also been carried out in the areas.
2. The low-voltage network has been built with underground cabling in the same area as the medium-voltage network where this has been technically and financially justified in connection with the installation of medium-voltage cabling. The maintenance programme actions have also been carried out in the area.
3. In addition, the medium-voltage and low-voltage networks in the development zones have been built even in a fast schedule, as far as possible, in cooperation with other operators that build and maintain civil engineering networks. This has made it possible to upgrade the network cost-efficiently, minimising the inconvenience caused to users in the areas in question.

Development zone 6

1. Maintenance programme actions have been carried out for the medium-voltage network in a way that ensures the network's safety and security of electricity supply. In the medium-voltage network, individual poles and cross-arms have been replaced on the basis of inspection findings. In the development zone, forests in areas adjacent to the electricity network have been managed extensively.
2. The maintenance programme actions has been carried out in the low-voltage network.

Development zone 7

1. New battery systems have been developed together with an energy company and an equipment manufacturer.
2. The operation of the pilot site in Elenia's network has been monitored and analysed.
3. The maintenance programme actions has been carried out in the network of the development zone.

5. Electricity distribution network meeting the quality requirements after the actions of the preceding two years

Information about actual figures are based on information reported from the network information system.

Table 56: Network that meets the quality requirements, in 2024–2025

2024					
Voltage level	**0.4 kV**	**20 kV**	**45 kV**	**110 kV**	**Total**
Network that meets the quality requirements, km	31,658	18,514	328	1,528	52,028
2025					
Voltage level	**0.4 kV**	**20 kV**	**45 kV**	**110 kV**	**Total**
Network that meets the quality requirements, km	32,332	19,163	305	1,545	53,345

Table 57 shows the route length that involved joint construction and its share of the total route length built.

Table 57: Share of joint construction of the route length built

	2024	2025	Comments/ Further details
Share of joint construction [km]	30	53	83
Share of joint construction [%]	6.8 %	9.5 %	8.3 %

6. Significant distribution network investments made in order to connect new production and new loads in the preceding two years

Table 58 shows the significant network investments made in order to connect new production and new loads.

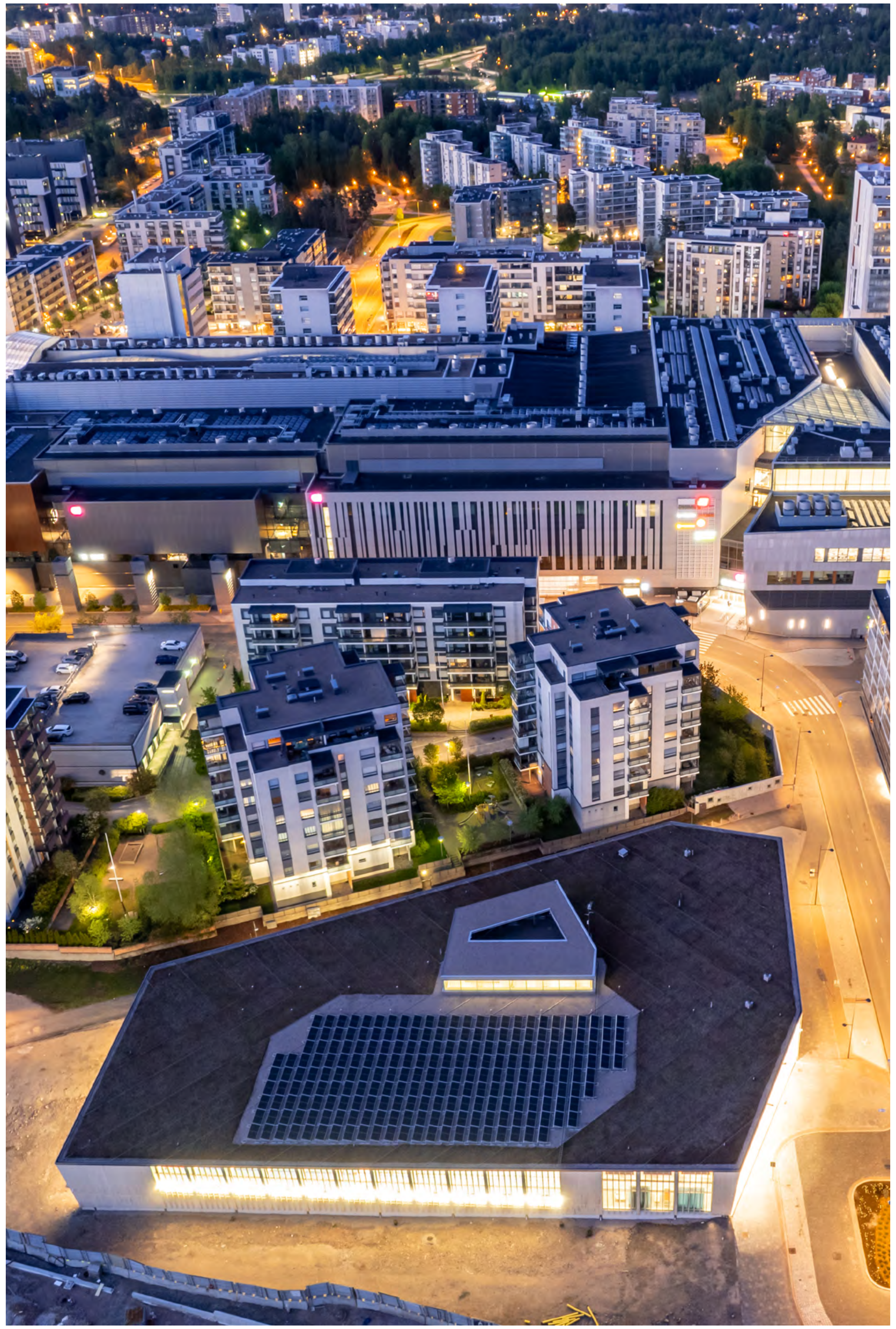
Table 58: Significant investments made in order to connect new production and new loads in the preceding two years

	2024 EUR 1,000	2025 EUR 1,000	Comments/ Further details
High-voltage network and substations	10,174	17,814	
Increase of the distribution network capacity in connection with upgrading	3,530	3,710	
Distribution network expansion investments	14,309	9,954	
Smart meters	30,343	13,533	
Total	**58,356**	**45,008**	**103,364**

In the high voltage network, four entirely new 110 kV transmission lines were constructed, two lines were refurbished, and modification works were carried out on two existing lines in connection with transmission grid construction projects. In 2024–2025, two entirely new substations were built, and several substations were expanded to increase capacity, including the installation of 110 kV voltage transformers and the implementation of protection modifications. The above mentioned investments in the high voltage network and substations were made primarily to enable the connection of new electricity generation. In addition, investments were made in the high voltage distribution network mainly in the vicinity of urban areas to increase transmission capacity and improve the security of electricity supply.

Investments were also made in the medium voltage and low voltage networks to enable grid connections for clean transition projects, such as construction projects for fast charging of electric vehicles and electricity storage facilities. In connection with the renewal of the medium voltage and low voltage networks, network capacity was increased to allow the connection of new generation and new loads. Lines were constructed with higher capacity than before, and increases in distribution transformer capacity were enabled through structural design choices at substations and by increasing their number. In addition, network capacity was increased based on customer driven needs so that growing generation and consumption could be connected to the network. The distribution network was also expanded, for example, to connect new residential and industrial areas. Investments made to serve individual consumer connections are not included in the figures.

The large scale replacement project for next generation smart meters, launched in 2021, was completed in 2025. These meters enable more accurate measurement and, consequently, more precise network dimensioning as electricity use changes due to the energy transition, as well as control functionalities where required by the evolving electricity market.



7. Use of flexibility services in the preceding two years

Studies and pilot projects

Elenia participates as a member in two projects monitoring the development of grid flexibility services: the Value for Flexibility (V4F) and FinFlex projects. The Value for Flexibility (V4F) project is implemented jointly by LUT University and Tampere University and focuses, among other things, on developing tools for electricity demand modelling, demand response analysis and electricity network analysis. These tools make it possible to assess electricity network loading, the availability of new forms of flexibility and the functioning of the electricity market. FinFlex is a new congestion management market in which Helen Sähköverkko and Fingrid are piloting smart flexibility solutions for managing electricity network bottlenecks.

As part of the next-generation smart meter replacement project, Elenia has promoted the implementation of flexibility services through its own activities. The meters include, for example, a load control relay for customer use, which can be programmed via the Elenia Aina customer portal to operate during the lowest-price spot electricity hours. Elenia initiated and participated in a co-development project in which the Finnish company Cozify Oy developed a reader for private use for the electricity meter's home automation interface, i.e. the HAN port. With the reader, customers can monitor their own electricity consumption more accurately and build various automated controls for electrical appliances. The reader is available through online retailers. The functionalities enabled by the new smart meters have not yet materialised as flexibility services that can be directly utilised by the distribution system operator, but through its own actions Elenia seeks to promote and enable the development of new solutions.

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Flexibility services used

The three electricity storage units in the flexibility services for the security of supply zone are currently operating in the frequency reserve market and in Elenia's use in automatic isolated operation during disruptions. The benefits of the network company are realised when disruptions happen, approximately 5–10 times a year. The realised costs are presented in Table 58. In addition, reactive power compensation made with the converter will result in cost savings of approximately EUR 7,500 per year in reactive power fees, which have not been taken into account in the figures in Table 58. The actual development, design and construction costs of the new battery equipment are also presented in Table 58.

Table 59: Actual costs of flexibility services in 2022–2023

	2024 EUR 1,000	2025 EUR 1,000	Total	Comments/ Further details
Deployment costs	38.3	34.9	73.2	Planning and construction of 2 projects to be installed in 2025
Operational costs	3	3	6	Pilot project in operation
Cost benefits	15	15	30	Annual savings in regulatory outage costs (harm caused due to outages), estimate

8. Performance in the preceding two years compared to the previous submitted development plan

The development plan submitted in 2024 and the actual outcomes for 2024 and 2025 are consistent in principle. The most significant deviations and their underlying reasons are presented below:

1. The reported amounts of distribution network expansion investments made to connect new consumption and generation in 2024 and 2025 were in total more than EUR 11 million higher than estimated in the 2024 development plan. The sharp increase in investment volume was driven by new medium voltage consumption and generation connections, the connection of which in practice almost always requires network development. Due to the statutory connection obligation, these investments must be implemented even if they were not originally planned.
2. Replacement investments in substations had to be postponed as a result of prioritising substation investments required to connect new generation and consumption. In addition, long delivery times for 110 kV components have challenged project implementation. Replacement investments were carried out at slightly more than EUR 10 million below the level estimated in the 2024 development plan. Correspondingly, customer driven investments required by new generation and consumption were implemented as planned.
3. Replacement investments in the distribution network differ from the plan, but when secondary substations are included, the overall level corresponds to the plan. This is due to the fact that investment projects are not in practice planned or reported at component level, and the allocation between substations and the medium voltage network is therefore to some extent artificial.
4. Outside zoned areas, the number of metering points meeting the quality requirements was approximately 1,000 lower than planned for 2024, while in zoned areas, nearly 1,500 more metering points than planned were brought within the scope of the quality requirements.

9. The network operator must submit a map of the areas that meet the quality requirements

Elenia has submitted information about the areas that meet the quality requirements of the Electricity Market Act at the end of 2025 to the verkkotietopiste.fi service as part of the publication of the development plan. In addition, the Elenia Avoin service provides information about customer-specific security of electricity supply and a forecast of its development.

ELENIA AVOIN

Tell us your thoughts on the most important everyday service – electricity.

Our development plan feedback is open
in our Elenia Avoin service until May 31, 2026.
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Background materials

Appendix 1: Asset management policy
Appendix 2: Environmental policy
Appendix 3: Occupational health and safety policy
Appendix 4: Procurement policy
Appendix 5: Information security policy
Appendix 6: Environmental management system, ISO 14001 certificate
Appendix 7: Safety management system, ISO 45001 certificate
Appendix 8: Asset management system, ISO 55001 certificate
Appendix 9: Information security management system, ISO 27001 certificate
Appendix 10: Playbook for major power disruptions